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BULLETIN OF THE TORREY BOTANICAL CLUB
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ECOLOGY OF CEDAR GLADES. I. DISTRIBUTION OF GLADE FLORA IN TENNESSEE[1]

ELSIE QUARTERMAN

Tennessee "cedar glades" are located in the Central or Nashville Basin that occupies most of the middle part of the state. The distinctive character of the vegetation of the glades has provoked the interest of many botanists but most investigations have been taxonomic rather than ecological. It is the purpose of this paper to present a general description of cedar glades as they occur in Tennessee and to discuss the maintenance of the plant communities existing upon them.

The Central Basin is cut into the Interior Low Plateau which, although not a part of the Appalachian System, has had a similar geologic history (Fenneman 1938). It is a fertile region similar to the better known Blue Grass country of Kentucky. Rolling upland pastures and rich alluvial farmlands are typical of the Basin except for the rocky barren flats that support "cedar glade" growth. These flats are formed where horizontal layers of Lebanon limestone are exposed (fig. 1), and occupy approximately 300 square miles, that is, about 5 or 6 per cent of the Basin. Lebanon limestone is Ordovician rock of the Stones River Series (Wilson 1940), the oldest geologic formation in Middle Tennessee that is now exposed. Glade areas lie, therefore, in the lowest parts of the Basin and are separated from each other by rounded hills and uplands that were not removed by the erosive forces that formed the lowland.

Large areas of glade rock are covered by thin soil that averages less than a foot in depth (Galloway 1919). Small sink holes and vertical fissures in the rock afford considerable subterranean drainage. When such fissures fill with soil a characteristic alternation of strips of exposed rock and soil results. The strips of soil are frequently wide enough that large trees grow in them, but sometimes they are merely cracks that afford space for only a narrow line of herbs. The extent of exposed rock varies from a few square feet to a quarter of an acre more or less.

The original vegetation of the Central Basin must have been a magnificent mixed mesophytic forest. Killebrew and Safford (1874) speak of yellow poplar trees six and seven feet in diameter, and of black walnut, maple, hickory, elm and oak in great abundance and of enormous size. These, as well as ash, beech and cedar, were cut in quantities. Lists of trees abun-

[1] Portion of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of Arts and Sciences of Duke University. June, 1949.

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dant in the original forest consistently include linden, buckeye, sassafras of tree size, hackberry, coffee tree and sweet gum (Killebrew 1898; Killebrew and Safford 1874; Safford 1884; and Sargent 1884). The hardwoods were only on good soil. Red cedar forests grew so exclusively upon glade limestone that the boundaries of the limestone outcrop could be distinguished by those stands (Killebrew and Safford 1874).

FIG. 1. Small quarry showing thin-bedded Lebanon limestone on which glades occur.

Only fragments of the original mesophytic forest exist today. The Central Basin is cleared except for oak-hickory ridges and cedar glades. Great quantities of cedar have been cut from the glades, the choicest trees are gone and the young growth is usually cut by the time diameters are sufficent for fence posts. Few present stands support Wherry's assertion

(1922) that red cedar reaches its best development in the limestone barrens of Tennessee, but the extent of the glades and the general composition of the vegetation are much the same as in pioneer days.

Methods. The most conspicuous plant communities of glade areas are the stands of cedar and the open grassy glades that include most of the endemics and many of the species whose presence here seems anomalous. An attempt was was made to study enough concrete examples of these two communities to be able to consider them in an abstract sense. Distribution studies were made of a number of areas throughout the Central Basin to determine the constancy of glade species. Constancy is considered as an expression of the degree of regularity with which a species is repeated in different examples of a community, as determined by examination of sample areas rather than of entire stands. By considering the results of frequency determinations in concrete communities in combination with the concept of constancy of species in the abstract community, one obtains an additonal synthetic concept, homogeneity of the association (Braun-Blanquet and Pavillard 1928). Five constancy classes are commonly recognized and only those species which fall into class 5, present in over 80% of the samples, are considered "constants" (Braun-Blanquet 1928).

Since glades in Middle Tennessee are restricted to outcrops of Lebanon limestone, these outcrops were located by means of a geologic map (Wilson 1940) and most of the larger ones inspected. From these, representative glades were selected in which sample areas were checked for constancy of species. The sample area was an oval measuring 15 by 30 paces. The size seemed adequate when compared to quantitative data obtained from selected preliminary samples, and the oval shape proved easy to measure in the field. Except for epiphytes, all plants observed in each area were listed. Twenty-two examples of open glades and 10 of glade woods were sampled in this manner. Sample areas were scattered through Bedford, Davidson, Maury, Rutherford, Williamson and Wilson Counties. Distribution lists were compiled in June, July and August so the summer flora is more adequately represented than that of other seasons.

On the same trips that were taken over the Basin to obtain constancy data, observations were made on the fidelity of species in glade communities. Until constancy data are available for all communities of the entire region, species can only be given fidelity ratings based upon the opinion of the observer. The floristic individuality of open glades is one of their most striking features and the characteristic species are so evident that it is impossible to give an adequate picture of cedar glades without placing emphasis upon them. Fidelity is discussed on a regional basis, glade areas being compared only with other Central Basin habitats. Species were grouped into 5 fidelity classes, and those with fidelities of 3–5 were termed

"characteristic" species (Braun-Blanquet 1928). Even though further study may show some of these values to be inaccurately assigned, some indication of species most closely restricted to glade is desirable now. Gattinger's annotations (1901) of the species considered here as "characteristic" indicate a similar opinion concerning the extent of their distribution.

Results. Records of the constancy of distribution of species in glade areas are presented in constancy diagrams (fig. 2), which show a normal distribution of species, as compared with Braun-Blanquet's (1928) diagrams, in the five classes both in open glades and glade woods.

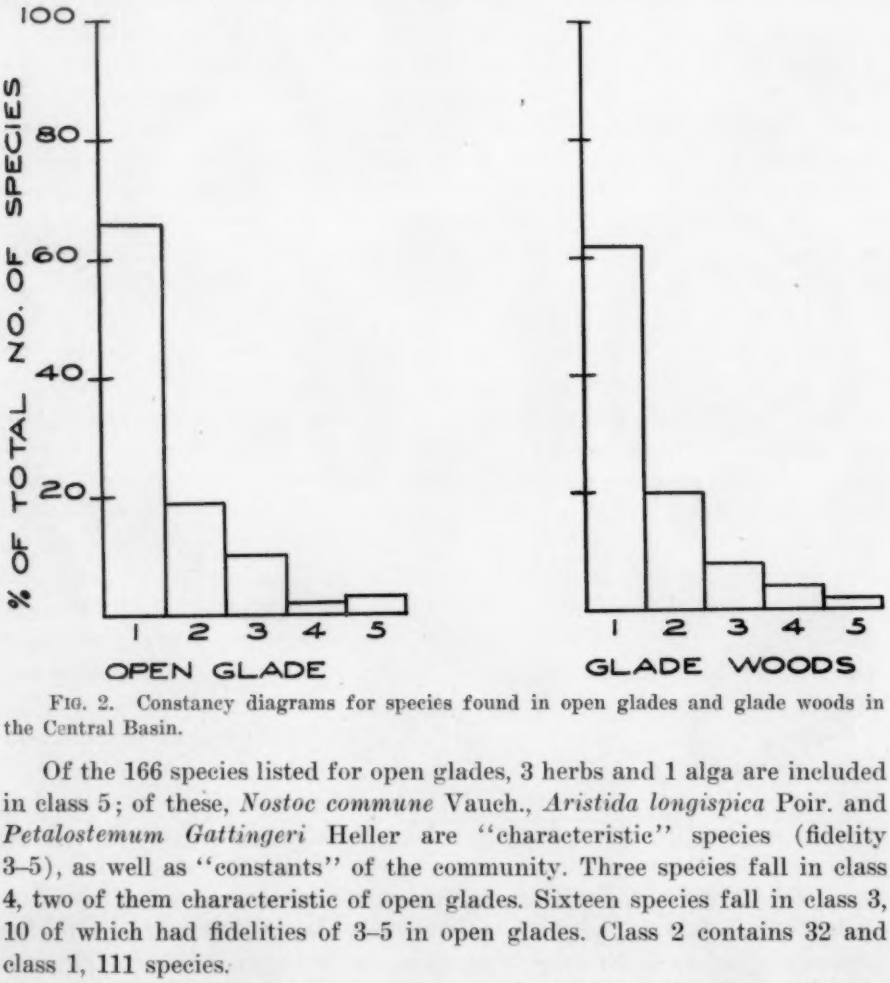

FIG. 2. Constancy diagrams for species found in open glades and glade woods in the Central Basin.

Of the 166 species listed for open glades, 3 herbs and 1 alga are included in class 5; of these, *Nostoc commune* Vauch., *Aristida longispica* Poir. and *Petalostemum Gattingeri* Heller are "characteristic" species (fidelity 3–5), as well as "constants" of the community. Three species fall in class 4, two of them characteristic of open glades. Sixteen species fall in class 3, 10 of which had fidelities of 3–5 in open glades. Class 2 contains 32 and class 1, 111 species.

A hundred and ninety-one species were listed in glade woods. Of these, 6 species fall in class 5; two of them, *Juniperus virginiana* L. and *Pleuro-*

chaete squarrosa (Brid.) Lindb., are species characteristic of glade woods. Of the 11 species falling in class 4, 3 shrubs, *Forestiera ligustrina* (Michx.) Poir., *Hypericum frondosum* Michx. and *Rhamnus carolinana* Walt., were assigned fidelities of 3–5. Class 3 includes 19 species, none of which is characteristic; 36 species fall in class 2, and 119 in class 1.

Seven per cent of the total number of open glade species and 53% of the species in constancy classes 3–5 are characteristic (fidelity 3–5). Three per cent of the total number of glade woods species and 13% of the species in constancy classes 3–5 are characteristic. This distribution of characteristic species indicates a more distinctive vegetation in open glades than is found in glade woods.

Discussion. A close relationship between physiography of the region and vegetation is shown in the correlation of glade communities with exposures of Lebanon limestone, which is a member of the Stones River Group of Ordovician age. Cedar glades in Lee County, Virginia are also on dolomitic limestone of the Stones River Group, Ordovician period (Carr 1944); somewhat similar glades in the Ozark region of Missouri are on dolomite or dolomitic limestones of Ordovician age (Erickson, Brenner and Wraight 1942); and prairie relics in Ohio which include a number of the same species are on soil derived from dolomitic limestone (Braun 1928). Such a distribution in such widely separated areas can hardly be coincidental.

The sporadic distribution of glade species was pointed out by Gattinger (1887). Hyperdispersion is also shown by frequency diagrams (Quarterman ms.) of concrete communities in which class A is disproportionately high, and is further emphasized by the high per cent of total number of species in constancy class 1. The greater number of sporadic species are included in the herb and cryptogam layers. The small number of herbs in constancy class 5 of open glade communities and the complete lack of herbs in that class in glade woods is further indication of the sporadic distribution of herbaceous species. The small number of "constants" relative to total number of species indicates lack of homogeneity in the abstract community as well as in individual stands. Both open glade and glade woods are heterogeneous communities made up of a few "constants" and many hyperdispersed non-constants.

Braun-Blanquet (1928) assigns several reasons for fidelity of species to particular areas, many of which are applicable to glade flora. A number of the species characteristic of cedar glades are paleo-endemics. The following glade species are included in a list of species (Steyermark 1934) that are restricted to the southern Appalachians and the Ozarks, two centers of survival and distribution of ancient floras: *Agave virginica* L., *Galium virgatum* Nutt., *Grindelia lanceolata* Nutt., *Leavenworthia uniflora* (Michx.) Britton, *Ophioglossum Engelmannii* Prantl, *Isoetes Butleri* Engelm. (*I.*

melanopoda Gay. and Dur.), *Heliotropum tenellum* (Nutt.) Torr., *Lobelia leptostachys* A. DC. (*L. spicata* var. *leptostachys* (A.DC.) Mack. and Bush), *Passiflora lutea* L., and *Satureja glabella* (Michx.) Briquet.

Endemics of cedar glades of Middle Tennessee are *Lobelia Gattingeri* A. Gray (McVaugh 1936), *Leavenworthia torulosa* A. Gray (Small 1933), *Petalostemum foliosus* A. Gray (Svenson 1940), *P. Gattingeri* Heller (Small 1933) and *Psoralea subacaulis* T. & G. (Small 1933; Svenson 1940).

Hypericum frondosum Michx. reaches its best development in cedar glades near Nashville (Svenson 1940) and is otherwise restricted to limestone bluffs and rocks in Tennessee and Alabama. Other near-endemics are *Oxalis recurva* Ell. var. *macrantha* (Trelease) Wiegand (Svenson 1940) and *Leavenworthia stylosa* A. Gray (Baldwin 1945). *Leavenworthia aurea* Torr. has a disjunct distribution, its range including areas in Alabama and Tennessee and in Texas and Oklahoma (Baldwin 1945).

Although the dominants are different, many of the same species of herbs are considered "characteristic" species of open glades in Missouri and their restriction to those glades is explained on the basis of being calciphilous (Steyermark 1934). The calciphilous habit may be ruled out in explaining the restriction of these species to open glades in Tennessee, because the entire Central Basin is calcareous. Some other factor or combination of factors is limiting here.

More than half the annual precipitation (50 inches) occurs from December to May, inclusive. The occasional droughts are usually in late summer and autumn, although there is a gradual lessening of precipitation from about April through the rest of the summer. One group of glade plants flourishes and blooms in early spring when the ground is saturated. *Leavenworthia* spp., *Nothoscordum, Schoenolirion, Isoetes, Oxalis violacea* L., *Houstonia patens* Ell., *Ophioglossum Engelmannii, Arenaria patula* Michx. and many others become dormant by early summer and survive the dry period as seed or as corms or bulbs. Another group is dormant through the winter and spring and blooms in the dry summer and fall. *Aristida, Agave, Evolvulus, Grindelia, Heliotropum, Isanthus,* all xerophytes, are in this group. *Yucca flaccida* Haw and *Opuntia Rafinesquii* Engelm. are perennial xerophytes that add new growth mainly during spring and early summer. The ability to endure the extreme drought of late summer and fall and the period of saturation in winter and spring is undoubtedly due in part to the time of dormancy. Winter and spring saturation in Missouri glades was mentioned (Erickson, Brenner and Wraight 1942) as a possible factor in excluding species by winter rotting. The occurrence of both wet and dry extremes must limit the number of species capable of living in glade areas.

Restriction of certain species to glades is probably also affected by their inability to compete with mesic species in more favorable habitats. Those species which are able to endure the extreme conditions of glades have less competition there and survive, but do not spread beyond the glade areas. Two introduced species, *Belamcanda chinensis* (L.) DC. and *Broussonetia papyrifera* (L.) Vent. apparently fulfill these conditions. Both were introduced from Asia (Robinson and Fernald 1908), have escaped from cultivation and become widespread in the glades but in no other habitats in the Central Basin. A number of prairie species including *Evolvulus argenteus* Pursh., *Bouteloua curtipendula* (Michx.) Torr., *Asclepiadora viridis* (Walt.) Gray, *Delphinium virescens* Nutt., *Vernonia missurica* Raf. and other eastern species of western genera probably survive in the glades for the same reasons, physiological ability to endure both saturation and desiccation, and lessened competition from mesic plants because of extreme moisture conditions in the glades.

Baldwin (1943; 1945) found the Nashville Basin to be the center of variability for species of *Leavenworthia* and for *Sedum pulchellum* Michx. He suggested that the patchiness of the soil in glade regions permits many separate populations of *Leavenworthia* within which differentiation may occur and proceed at a rapid rate because the plants are annuals. Perhaps other glade endemics arose in a similar fashon.

The hexaploid race of *Sedum pulchellum* occurs in Tennessee where diploid and tetraploid races meet (Baldwin 1943). Physiological investigations of polyploids of this species showed that hexaploid races were better able to withstand both excess and deficiency of water than other races and that diploids had least tolerance to moisture extremes (Smith 1946). This suggests that the individuals of *Sedum pulchellum* that survive in glades probably belong to a hexaploid race.

Conclusions. 1. The vegetation of open glades and glade woods constitutes heterogeneous but distinct communities, made up of a few "constants" and a number of sporadic species.

2. Open glade communities have greater floristic individuality than glade woods, as shown by the number of "characteristic" species among the "constants" of the community.

3. Cedar glade vegetation is closely related to type of substrate, as shown by the presence of similar glades on Ordovician limestone in Tennessee, Virginia and Missouri. Restriction of species to cedar glade communities can hardly be determined by the presence of limestone since the entire Central Basin is calcareous. Stratigraphy, however, controls the drainage of water in Tennessee and Missouri glades and that is probably its main controlling effect.

4. Paleo-endemics, remnants of an ancient flora now restricted to a few areas, and species indigenous only to Tennessee glades may survive there because of ability to endure both wet and dry extremes. This may in part be controlled by time of dormancy and degree of polyploidy, and to lack of competition from mesic species which are excluded by the extreme conditions in glades. This hypothesis cannot be proved without autecological experiments with species typical of glade flora.

SUMMARY

"Cedar glades" cover about 5 per cent of the Central Basin of Middle Tennessee at an average elevation of 600 feet. They occupy the flat exposures of Lebanon limestone in an otherwise fertile region. Soil is thin and rocky and moisture conditions are extreme. The soil is saturated much of the time from December to May, the period of greatest precipitation, and becomes increasingly drier through the summer and fall. Open glades and woods dominated by red cedar (*Juniperus virginiana*) are the most typical communities of the region.

Both open glades and glade woods are heterogeneous communities, made up of a few "constants" and a large number of sporadic species, most of which are herbs.

There is a close relationship between physiography and vegetation as evidenced by the restriction of glade vegetation to Lebanon limestone in the Central Basin and by the presence of similar glades on Ordovician limestone in Virginia and Missouri. This is probably a matter of available moisture controlled in part by stratigraphy.

Ability to survive the spring saturation and fall drought is a factor in determining restriction of species to glade habitats. The plants which are able to survive these conditions meet less competition from mesic species which are unable to invade glade areas. Among species characteristic of glades are endemics, disjuncts and eastern species of western genera.

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Literature Cited

Baldwin, J. T. 1943. Polyploidy in *Sedum pulchellum* I. Cytogeography. Bull. Torrey Club **70:** 26–33.

———. 1945. Chromosomes of *Cruciferae* II. Cytogeography of *Leavenworthia*. Bull. Torrey Club **72:** 367–378.

Braun, E. L. 1928. Glacial and post-glacial plant migrations indicated by relic colonies of southern Ohio. Ecology **9:** 284–302.

Braun-Blanquet, J. 1928. Plant sociology: the study of plant communities. (Trans., rev. and ed. by G. D. Fuller and H. S. Conrad.) New York.

——— **and J. Pavillard.** 1928. Vocabulaire de scociologie vegetale. 3rd ed. Montpelier.

Carr, L. G. 1944. A new species of *Houstonia* from the cedar barrens of Lee County, Virginia. Rhodora **46**: 306–310.

Erickson, R. O., L. G. Brenner and J. Wraight. 1942. Dolomitic glades of east-central Missouri. Ann. Mo. Bot. Gard. **29**: 89–101.

Fenneman, N. M. 1938. Physiography of the Eastern United States. 1st. ed. New York and London.

Galloway, J. J. 1919. Geology and natural resources of Rutherford County, Tennessee. Nashville, Tennessee. Tenn. Geol. Bull. **22**: 1–81.

Gattinger, A. 1887. Tennessee Flora. Nashville, Tenn. Published by the author. 109 pp.

————. 1901. Flora of Tennessee and Philosophy of Botany. Tenn. Bur. of Agr., Statistics and Mines. Nashville, Tenn. 296 pp.

Killebrew, J. B. 1898. Information for immigrants concerning Middle Tennessee. Passenger Dept., N. C. & St. L. Railway. Nashville, Tenn.: Marshall & Bruce. 140 pp.

———— **and J. M. Safford.** 1874. Introduction to the resources of Tennessee. Nashville, Tenn.: Tavel, Eastman and Howell. 11 pp.

McVaugh, R. 1936. Studies in the taxonomy and distribution of the North American species of *Lobelia*. Rhodora **38**: 346–362.

Quarterman, E. (Major plant communities of Tenn. cedar glades.) (In press).

Robinson, B. L. and M. L. Fernald. 1908. Grays's New Manual of Botany. 7th ed. New York.

Safford, J. M. 1884. Part I. Cotton Production in the Mississippi Valley and southwestern states. Tennessee and Kentucky. United States Tenth Census, **5**: 383–416. Washington: U. S. Census Office.

Sargent, C. S. 1884. Forests of North America. United States Tenth Census, **9**: 1–612. Washington: U. S. Census Office.

Small, J. K. 1933. Manual of the southeastern flora. New York.

Smith, H. E. 1946. *Sedum pulchellum:* a physiological and morphological comparison of diploid, tetraploid and hexaploid races. Bull. Torrey Club **73**: 495–541.

Steyermark, J. A. 1934. Some features of the flora of the Ozark region in Missouri. Rhodora **36**: 214–233.

Svenson, H. K. 1940. Plants of the southern United States. Rhodora **42**: 7–19.

Wherry, E. T. 1922. Soil acidity preferences of some eastern conifers. Jour. Forest. **20**: 488–496.

Wilson, C. W. 1940. Progress geologic map of Middle Tennessee. Bull. 48, Tennessee State Div. of Geol. Publ.

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THE METABOLISM OF SPECIES OF STREPTOMYCES. II. THE NITRATE METABOLISM OF S. COELICOLOR[1]

VINCENT W. COCHRANE AND JEAN E. CONN

In studies on the carbon metabolism of *Streptomyces coelicolor* (Müller) Waksman and Henrici, it became evident that certain interactions occur between carbon and nitrogen metabolism, so that the suitability of a given nitrogen compound may vary with the nature of the other nutrient materials present. In particular, the poor growth and anomalous pH cycle of the organism in a glucose-nitrate medium (Cochrane and Conn 1947) required explanation. There was abundant evidence that nitrate was utilized as a source of nitrogen, but the level of growth was low, and the pH fell markedly instead of exhibiting the expected rise as a result of preferential absorption of the nitrate ion from sodium nitrate. The present work is restricted to an analysis of the factors affecting the growth of *S. coelicolor* in nitrate media.

Methods. The organism and the cultural methods used have been described in the preceding paper of this series (Cochrane and Dimmick 1949). All media contained glucose 0.05M, K_2HPO_4 0.003M, and $MgSO_4$ 0.001M. The nitrogen source was varied experimentally but all nitrogen media contained 0.210 g. per liter of nitrogen. Trace elements were provided in all cases, as follows: Zn, 0.5 p.p.m.; Fe, 0.5 p.p.m.; Cu, 0.02 p.p.m.; B, 0.005 p.p.m.; Mn, 0.01 p.p.m.; and Mo, 0.01 p.p.m. In some experiments Difco yeast extract was supplied as an organic supplement. The organism was grown in shake culture, and each determination represents four replicate flasks. Sugar was estimated by the method of Somogyi (1945), and nitrate by the phenoldisulfonic acid method (Prince 1945). Nitrite was determined by the method of Rider and Mellon (1946).

RESULTS

Sources of nitrogen utilized by S. coelicolor. In table 1 are shown typical data on growth and sugar utilization with different nitrogen sources. Evidently nitrate is used for growth but is not, by comparison with asparagine, a satisfactory source of nitrogen. Provisionally, the data suggest a toxic metabolic product or products arising from early nitrate metabolism

[1] This investigation was supported in part by a grant from the Division of Research Grants and Fellowships of the National Institute of Health, United States Public Health Service, and in part by the Denison Research Fund of Wesleyan University. The assistance of Miss Isabel Dimmick in some of the experiments is gratefully acknowledged.

and having two effects: inhibition of further growth, and maintenance of a low pH. That the acidity itself was not the primary factor in restricting growth may be inferred from the fact that the aspartate medium supported good growth but had a terminal pH even lower than that of the nitrate medium.

Parenthetically, the nutritional equivalence of asparagine and ammonium aspartate suggests that the former is normally converted to the latter, either in the autoclave or later by the organism itself. The second suggestion is the more likely, in that the aspartate medium became so much more acid than the asparagine. Were asparagine wholly converted to ammonium aspartate during autoclaving, we would expect the two media to have the same metabolic history. Since they do not, it may be inferred that at least a major fraction of the amide survives autoclaving without hydrolysis. The acidity of the aspartate medium is presumably the result of preferential absorption of the ammonium ion.

TABLE 1. *Sources of nitrogen and growth of Streptomyces coelicolor*[a]

Nitrogen Source[b]	pH		Dry Weight	Residual Glucose
	Initial	Final		
			mg.	*mg./100 ml.*
None	6.60	6.32	4	890
L-Asparagine	6.95	6.16	123	171
Ammonium DL-aspartate	6.98	5.69	127	152
Casamino acids, Difco	6.38	5.60	33	443
Urea[c]	7.05	7.00	88	404
Sodium nitrate	6.75	5.90	53	486

[a] Basal medium: glucose 0.05M (900.8 mg./100 ml.), K_2HPO_4 0.003M, $MgSO_4$ 0.001M, $CaCO_3$ 3.0 gm./l., minor elements. Reciprocating shaker (95 cycles per minute, 9.0 cm. stroke), 24–25° C. Period of growth 8 days.

[b] Total nitrogen 0.210 gm./l.

[c] Sterilized separately by filtration.

No attempt was made to find an explanation of the poor growth with urea and with casamino acids; similar results were reported for surface cultures (Cochrane and Conn 1947).

The effect of acidity on growth in nitrate medium. Since it is known that *S. coelicolor* produces acid from glucose (Cochrane and Dimmick 1949), and that nitrite is produced from nitrate, a reasonable hypothesis to explain poor growth on nitrate media is that accumulation of nitrite at a low pH has toxic effects. This hypothesis is further supported by the known effect of acidity on the toxicity of weak acids in general (Rahn and Conn 1944) and of nitrous acid in particular (Tarr 1941).

One test of this hypothesis is the experiment reported in table 2. The organism was grown in nitrate and asparagine media with and without

periodic additions of sodium hydroxide. By the use of brom thymol blue as indicator and by adding alkali twice daily if needed, the pH could be maintained above 6.8 for most of the growth period. The control of pH was, obviously, only approximate.

The data of table 2, as far as they go, support the hypothesis suggested above, in that neutralization increased the growth with nitrate to the level of that with asparagine. Neutralization *per se* had no obvious effect on growth. The poor growth in the nitrate medium which was allowed to become acid is evidenced not only by the low mycelial weight but also by failure to utilize the sugar rapidly and by failure to consume either nitrate or nitrite completely. In all these respects, the neutralized nitrate medium was far superior.

TABLE 2. *The effect of acidity on the nitrogen metabolism of S. coelicolor*[a]

	Nitrogen Source[b]			
	Asparagine	$NaNO_3$	Asparagine	$NaNO_3$
Initial pH	6.92	6.75	6.92	6.75
Added 0.1N NaOH, ml./100 ml.	4.6	2.7		
Final pH	7.22	7.52	6.08	5.75
Dry weight, mg.	187	185	186	46
Residual glucose, mg./100 ml.	153	128	169	404
Residual nitrite[c]	–	–	–	+
Residual nitrite[c]	–	–	–	+

[a] Basal medium: glucose 0.05M (900.8 mg./100 ml.), K_2HPO_4 0.003M, $MgSO_4$ 0.001M, $CaCO_3$ 3.0 g. per l., yeast extract 0.25 gm./l., minor elements, brom thymol blue 0.16 mg./l. Reciprocating shaker, 24–25° C. Period of growth 8 days.

[b] Total nitrogen 0.210 gm./l.

[c] Qualitative tests.

The data of table 2 indicate an interaction of pH and nitrogen source but do not demonstrate the mechanism. The data next presented (table 3) support the hypothesis that the effect of acidity is on the toxicity of nitrite, not primarily on nitrogen assimilation. In this experiment nitrite was added to growing cultures already supplied with adequate nitrogen as asparagine. Some of the cultures were kept above pH 6.8, while comparable lots were not neutralized.

Comparing first the two media to which nitrite was added (B and D), it is apparent that neutralization improved growth and sugar utilization. Maintenance of the higher pH did not exert much effect on the quantity of nitrite disappearing, although this question is complicated by the fact that volatilization of nitrite may have occurred in the more acid medium. In any event, there is no indication that neutralization acts primarily by increasing

nitrite utilization. In the two media lacking nitrite, neutralization had no obvious differential effect.

Even at the higher pH, the amount of nitrite used was evidently somewhat toxic. This is not unexpected, since the pH control was only periodic and since the initial concentration of nitrite was much higher than any ever observed in a nitrate medium suitable for optimum growth.

Some experiments similar to that reported in table 3 show slight but definite increases in total growth attributable to the addition of nitrite. The utilization of nitrite for growth by *S. coelicolor* is in agreement with reports on other actinomycetes (von Plotho 1940, Waksman 1920).

The mechanism of interaction of carbon source and nitrate may be formulated therefore as follows. *S. coelicolor* produces acid from glucose and nitrite from nitrate. Under the conditions used, the amount of nitrite formed

TABLE 3. *The toxicity of nitrite to Streptomyces coelicolor*[a]

Medium	Added[b] $NaNO_2$	Added[c] 0.1N NaOH	Final pH	Dry Weight	Residual Glucose	Residual Nitrite
	mM/100 ml.	*ml./100 ml.*		*mg.*	*mg./100 ml.*	*mM/100 ml.*
A	.....	.....	6.81	90	27	0.00
B	1.68	.....	6.03	36	420	1.09
C	.....	13.9	7.10	88	146	0.00
D	1.68	5.8	7.03	72	133	1.31

[a] Basal medium: glucose 0.05M (900.8 mg./100 ml.), asparagine 0.0075M, K_2HPO_4 0.003M, $MgSO_4$ 0.001M, $CaCO_3$ 3.0 gm./l., yeast extract 0.25 gm./l., minor elements, brom thymol blue 0.16 mg./l. Initial pH 6.94. Reciprocating shaker, 24–25° C. Period of growth 6 days.

[b] Added 48 hours after inoculation.

[c] Added twice daily to maintain pH above 6.8.

is toxic at the low culture pH. The cessation or diminution of growth so induced prevents any further change. Neutralization of metabolic acids allows normal growth and under these conditions the final growth with nitrate is usually as heavy as that with asparagine.

The utilizability of nitrate as the sole source of nitrogen. The reason for the inclusion of yeast extract in the media used is found in the data of table 4, from which it is evident that growth is improved by this expedient when nitrate is the nitrogen source. This was true both with glucose and with glycerol as carbon source. In the absence of yeast extract, the nitrate media were somewhat inferior to asparagine. In its presence, the two nitrogen sources appear equally suitable.

It should be noted that the amount of yeast extract used was entirely inadequate by itself for normal growth with the indicated concentrations of carbon compounds. A rough estimate of the total nitrogen required in a medium containing 0.05M glucose is 0.21 g per L of total utilizable nitrogen.

The stimulating effect of yeast extract shown in table 4 has been found to be a rate effect, i.e. growth is faster but not in the end more luxuriant with yeast than without. In a typical experiment the maximum dry weight at 6 days with asparagine was 119.4 mg.; the peak dry weight with nitrate was not reached until the 10th day but was approximately the same, 110.6 mg.

It is also evident from the last two columns of table 4 that acid formation from glycerol is relatively slight, and neutralization therefore is not required in nitrate media. The same situation is found with mannitol as carbon source. These observations are indirect but positive support of the conclusion reached earlier that nitrate is a satisfactory source of nitrogen provided that the pH does not drop too far. The same conclusion may be drawn from the prior data of Waksman (1919).

TABLE 4. *Factors affecting the growth of S. coelicolor in nitrate media*[a]

Carbon Source	Nitrogen Source[b]	Yeast Extract	Dry Weight	Residual Glucose	Nitrite[d]	Added 0.1N NaOH	Final pH
		gm./l.	*mg.*	*mg./100 ml.*		*ml./100 ml.*	
Glucose	None	.....	0	862	–	0.0	6.76
	Asparagine	.....	147	119	–	5.6	6.78
	$NaNO_3$	.....	106	260	+	2.4	7.22
	None	0.25	24	688	–	5.2	7.11
	Asparagine	0.25	140	155	–	6.5	6.94
	$NaNO_3$	0.25	135	23	–	3.1	7.31
Glycerol[c]	None	.....	0.0	.....	–	0.0	7.30
	Asparagine	.....	181.5	.....	–	3.7	6.89
	$NaNO_3$	.....	135.3	.....	+	0.0	7.81
	None	0.25	19.8	.....	–	4.4	6.99
	Asparagine	0.25	192.7	.....	–	0.0	6.51
	$NaNO_3$	0.25	184.5	.....	–	0.0	7.82

[a] Basal medium: K_2HPO_4 0.003M, $MgSO_4$ 0.001M, $CaCO_3$ 3.0 gm./l., minor elements, brom thymol blue 0.16 mg./l. Reciprocating shaker, 24–25° C. Period of growth 8 days. All cultures kept above pH 6.8 by periodic additions of 0.1N NaOH.

[b] Total nitrogen 0.210 gm./l.

[c] Total carbon 3.60 gm./l. (glucose 0.05M, glycerol 0.1M).

[d] Qualitative test.

The data of table 4 show, in summary, that nitrate is utilized, that yeast extract improves growth with nitrate, and that other metabolic rates are similarly accelerated. The role of yeast extract may be in the provision of growth factors or of hydrogen donors for the reduction of nitrate (Quastel *et al.* 1925). In either case, the required factor is apparently synthesized by the organism in the absence of yeast but at a rate which is limiting to growth.

The course of metabolism in a nitrate medium. In figure 1 are plotted the significant data from an experiment designed to show the course of

growth and metabolism in a glucose-nitrate-yeast extract medium, neutralized as required to maintain the pH at or above 6.8.

Growth and the processes of sugar utilization, nitrate consumption, and nitrite formation and consumption, once started, follow the expected course. The striking feature is the long lag period, before initiation of growth or obvious chemical activity. In other experiments the period of lag has more usually been only 4 days, but the comparable lag period of an asparagine

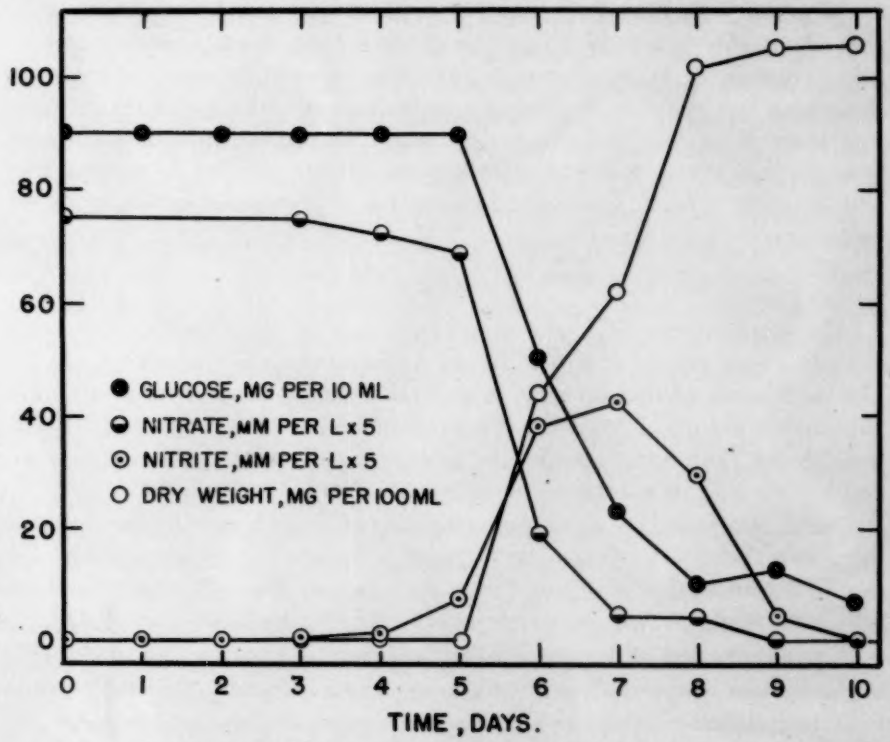

FIG. 1. The growth of *Streptomyces coelicolor* in a nitrate medium (glucose 0.05M, $NaNO_3$ 0.015M, K_2HPO_4 0.003M, $MgSO_4$ 0.001M, $CaCO_3$ 3.0 gm. per l., yeast extract 0.25 gm. per l., minor elements, brom thymol blue). pH maintained above 6.8 by periodic additions of NaOH. Reciprocating shaker, 24–25° C.

culture is at most one day (Cochrane and Dimmick 1949). The inference is that, even with yeast extract, the nitrate medium lacks an adequate supply of some essential metabolite. An equally likely hypothesis alternative to this would be to postulate that the lag period represents time necessary for production or reinforcement of adaptive enzyme systems, as recently reported in bacteria (Lewis and Hinshelwood 1948, Pollock 1946).

The use of nitrogen sources in taxonomic separation. It is generally found (Waksman 1919, 1920) that in any group of actinomycetes some will

and others will not reduce nitrate, and this criterion has been proposed in systematic separation (Taylor and Decker 1947). At least one species, *S. griseus*, has been proved to be unable to utilize nitrate nitrogen for growth (Thornberry and Anderson 1948).

An attempt was made to devise a simple routine test for systematic use. Since many actinomycetes will not grow well or at all in unaerated broth tubes, agar slants were used. The data are not reported in detail because of the negative finding that, even with washed agar, it is impossible to separate forms able to utilize nitrate for growth from those which are not so able. Apparently, there is enough available nitrogen in agar so that even *S. griseus* can grow on a glucose-nitrate-agar medium (Waksman 1920). The mass of growth is undoubtedly slight, but visual inspection of the agar surface does not differentiate nitrate-utilizing strains from those unable to utilize nitrate. Quantitative measures of growth appear to be necessary to make this distinction.

DISCUSSION

The unsuitability of a glucose-nitrate medium for *Streptomyces coelicolor* is a special case of a well-known phenomenon, the toxicity of nitrite. The mechanism of this toxicity, in general terms, is thought to be reaction with amino groups of enzymes (Stephenson 1949). More specifically, it has been shown that nitrite blocks the action of carboxylase and leads to an accumulation of its substrate, pyruvic acid (Nord and Mull 1945).

At an acid reaction, resulting in the case of *S. coelicolor* primarily from the accumulation of succinic acid (possibly reinforced by some accumulation of pyruvate), nitrite was found to be toxic. The influence of pH on nitrite toxicity has been noted by others (Meiklejohn 1940, Tarr 1941).

The observation of Jensen (1930) that there is a correlation in Streptomyces strains between ability to form acid and intensity of nitrate reduction is explained by the present data. More precisely, the correlation is between acid accumulation and failure to metabolize nitrite, the latter expressing a more general inhibition of growth and metabolism. Other work on the actinomycetes (von Plotho 1940, Waksman 1919) has shown the toxic influence of nitrite on these organisms.

Analytical and growth data leave no doubt that nitrate is reduced to nitrite and that the nitrogen is assimilated, possibly after further reduction to ammonia. The nitrate-reducing system operative in *S. coelicolor* in aerated culture must differ radically from the better-known "nitratase" of *Escherichia coli*, which functions anaerobically and is non-competitively inhibited by oxygen (Stickland 1931). Its relations are more probably with

the oxygen-insensitive nitrate reducing systems of the fungi (Ohtsuki 1936).

The value of nitrate as a nitrogen source, as well as the rate of its utilization, is seen to be dependent on other constituents of the medium, primarily the carbon source. Secondarily, the role of yeast extract cannot be neglected, although no explanation in terms of known compounds is possible at present. Considerations of this sort should be evaluated for any species of Streptomyces before reaching final conclusions as to utilizability of nitrate nitrogen or the meaning of a strong nitrite test.

The demonstration of nitrite toxicity in nitrate media throws considerable doubt on the use of such media in studies on variability (Eriksson 1948). Indeed, nitrite at toxic levels has been used successfully to induce heritable changes in fungi (Thom and Steinberg 1939). A sucrose-nitrate medium, e.g., the Czapek-Dox, might not be very toxic, inasmuch as sucrose is utilized only slowly if at all by *S. coelicolor* (Cochrane and Conn 1947) and acid production is probably negligible. But a glucose-nitrate medium, as used in some of the experiments of Eriksson, should, from the results described here, be toxic, since presumably 2.0 gm. per L. of nitrate was employed, as compared to 1.28 gm. per L. in the present work.

SUMMARY

Streptomyces coelicolor is able to utilize ammonium aspartate, asparagine, urea, casamino acids, and nitrate as sources of nitrogen, but maximum growth is obtained in a poorly buffered glucose medium only with the first two materials named. Growth inhibition in a glucose-nitrate medium results from the interaction of two metabolic systems, glucose dissimilation and nitrate reduction. At the low pH accompanying the formation of organic acids from glucose the nitrite produced from nitrate is toxic. The symptoms of toxicity are removed, and growth is normal, if the pH of such a medium is maintained at 6.8 or higher. In media having as carbon source glycerol or mannitol, metabolic acids do not accumulate and growth on nitrate is satisfactory.

Yeast extract accelerates growth on nitrate media, possibly by provision of compounds essential for the reduction of nitrate. The time course of growth on a neutralized glucose-nitrate medium with yeast extract includes a long lag period which may represent the time necessary either for the formation of adaptive enzymes or for the accumulation of oxidizable metabolites needed for the reduction of nitrate.

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Literature Cited

Cochrane, V. W. and Conn, Jean E. 1947. The growth and pigmentation of *Actinomyces coelicolor* as affected by cultural conditions. Jour. Bact. **54:** 213–218.

Cochrane, V. W. and Dimmick, Isabel. 1949. The metabolism of species of *Streptomyces.* I. The formation of succinic and other acids. Jour. Bact. **58.** (In press).

Eriksson, D. 1948. Differentiation of the vegetative and sporogenous phases of the actinomycetes. 3. Variation in the *Actinomyces coelicolor* species-group. Jour. Gen. Microbiol. **2:** 252–259.

Jensen, H. L. 1930. Actinomycetes in Danish soils. Soil Sci. **30:** 59–77.

Lewis, P. R. and Hinshelwood, C. N. 1948. Adjustments in bacterial reaction systems. I. The reducing power of *Bact. lactis aerogenes* under various conditions. Proc. Roy. Soc. (London) B **135:** 301–316.

Meiklejohn, Jane. 1940. Aerobic denitrification. Ann. Appl. Biol. **27:** 558–573.

Nord, F. F. and Mull, R. P. 1945. Recent progress in the biochemistry of *Fusaria.* Adv. Enzym. **5:** 165–205.

Ohtsuki, T. 1936. Untersuchungen über die Nitritverwendung und die Nitratreduktion bei Schimmelpilzen. Jap. Jour. Bot. **8:** 269–293.

von Plotho, O. 1940. Beiträge zur Kenntnis der Morphologie und Physiologie der Actinomyceten. Arch. Mikrobiol. **11:** 33–72.

Pollock, M. R. 1946. Adaptation of "nitratase" in washed suspensions of bacteria. Brit. Jour. Exp. Path. **27:** 419–432.

Prince, A. L. 1945. Determination of total nitrogen, ammonia, nitrates, and nitrites in soils. Soil Sci. **59:** 47–52.

Quastel, J. M., Stephenson, Marjory, and Whetham, Margaret D. 1925. Some reactions of resting bacteria in relation to anaerobic growth. Biochem. Jour. **19:** 304–317.

Rahn, O. and Conn, Jean E. 1944. Effect of increase in acidity on antiseptic efficiency. Ind. Eng. Chem. **36:** 185–187.

Rider, B. F. and Mellon, M. G. 1946. Colorimetric determination of nitrites. Ind. Eng. Chem. Anal. Ed. **18:** 96–103.

Somogyi, M. 1945. A new reagent for the determination of sugars. Jour. Biol. Chem. **160:** 61–68

Stephenson, Marjory. 1949. Bacterial metabolism. 3d ed. London.

Strickland, L. H. 1931. The reduction of nitrates by *E. coli.* Biochem. Jour. **25:** 1543–1554.

Tarr, H. L. A. 1941. Bacteriostatic action of nitrites. Nature **147:** 417–418.

Taylor, D. F. and Decker, P. 1947. A correlation between pathogenicity and cultural characteristics in the genus *Actinomyces.* Phytopathology **37:** 49–58.

Thom, C. and Steinberg, R. A. 1939. The chemical induction of genetic changes in fungi. Proc. Nat. Acad. Sci. **25:** 329–335.

Thornberry, H. H. and Anderson, H. W. 1948. Synthetic medium for *Streptomyces griseus* and the production of streptomycin. Arch. Biochem. **16:** 389–397.

Waksman, S. A. 1919. Studies in the metabolism of actinomycetes. II. Jour. Bact. **4:** 307–330.

————. 1920. Studies in the metabolism of actinomycetes. III. Nitrogen metabolism. Jour. Bact. **5:** 1–30.

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GENETICS AND TAXONOMY OF THE CULTIVATED BRASSICAS AND THEIR WILD RELATIVES

R. RUGGLES GATES

Over thirty years ago I collected and cultivated seeds of the wild cabbage from Shakespeare's cliff at Dover. The results, with remarks on Mediterranean species of *Brassica* which were possible ancestors of some of the cultivated forms, are soon to be published (Gates, 1950), together with a summary of the genetics. It has since been possible to examine the literature further. The following notes have a bearing on the question of the origin and variation of cultivated Brassicas. Some forty Mediterranean species of *Brassica* have been recognized, growing especially on chalk soil. The synonomy, especially of the cultigens, is much mixed, but no attempt has been made here to settle questions of priority. Names have been used here in some cases because they seemed most suitable in indicating relationships. The species *B. Napus* and *B. campestris*, and their varieties have been much bandied about.

Blaringhem (1925) found a perennial form of *Brassica oleracea* L. on the chalk cliffs of the French coast at Cape Blanc-Nez near Wimereux, which he called var. *suffruticosa*. It apparently corresponds to *B. oleracea* subsp. *oleracea* Huds. and var. *sylvestris* DC. Seeds were collected in 1901 and cultivated at Locon, 60 kilometres inland, the strain remaining perennial and suffrutescent. The first sowing was four years old when the plants were accidentally destroyed. The cultivated plants were much larger than the wild, and branched. The coastal plants showed much abortion of flowers and few seeds, probably owing to self-sterility, and few insect visits; young plants were never found on the cliffs. The inland cultures flowered abundantly and were fully fertile. Another collection of coastal seeds in 1910 produced plants over two metres high, which were used to cross with radishes. These plants were still living in 1915. Seeds from spontaneous plants in this culture were collected in 1919 and some of the resulting plants lived six years. Collection from other parts of the French coast differed in seed characters, the Blanc-Nez form being intermediate in seeds and fruits between the forms in Heligoland and those of the Channel and further south (Charente-Inférieure). The var. *Pourettii* (= *B. montana* Pourett, 1788), differs in characters of the siliqua, seeds and inflorescence.

Gabriel (1928) described a form from the south coast of France in the vicinity of Toulon which is called *B. Robertiana* J. Gay, but which differed from Blaringhem's variety in the lobing of the leaves, which are all petio-

late, and in minor characters of the pedicels and seeds. The seeds from a young plant taken into cultivation gave uniform plants in 1921, except one which was much branched, having decumbent branches 1.2 m. long which bore many short branches with terminal rosettes of leaves. Seeds of this plant reproduced the *Robertiana* type in 1922 and 1923,[1] but in 1924 and later years there was segregation into three types: (a) leaves more fleshy and twice as large, with winged petioles and crinkled leaves like Savoy (*B. oleracea* var. *Sabauda*); (b) after flowering, the stem grew in length and thickness, the leaves fell, leaving imbricated leaf scars from the axils of which buds developed as in Brussels sprouts (*B. oleracea* var. *gemmifera* Zenker); (c) the inflated stem reached a diameter of 5 cm., the abundant sessile rosette leaves reaching 25 cm. in length, very fleshy with a violet midrib and a heavy wax layer as in cabbage (*B. oleracea* var. *capitata* L.). The descendants of these three types are said to have remained true in later years. According to the account, these "mutations" appeared only in the third year of cultivation, the plants being covered only with gauze to prevent insect visits, and producing seeds in the first two years which came true to type. It is impossible to accept this account, which is not genetically critical, without reservations. If true, it would indicate that a single plant produced forms resembling Savoy, Brussels sprouts and cabbage leaves.

B. Robertiana was originally collected near Toulon, and Gay (1826) regarded it as nearly related to *B. oleracea* of Nice. It has yellow petals, at least near Toulon. Cavara (1890) described a perennial form from the Appennines, on rocks at an elevation of *ca.* 800 m., which he called *B. Robertiana* var. *appenina*. It came true from seeds, producing flowers and fruits in the second year. It grew over 1 m. high, with leaves 40–50 × 20–30 cm., and was regarded as a possible forage plant. It was considered to belong to the general type of *B. oleracea*, having affinities with *B. balearica* Pers., *B. Robertiana* Gay and *B. cretica* Sibt. and Sm.

Holmboe (1914), in a study of the Cyprus flora, described *B. Hilarionis* Post,[2] as a species nearest *B. cretica* and perhaps only a subspecies of *B. cretica* but apparently not related to *B. oleracea*. The petals were rose or white (not yellow), the siliqua 10 mm. (not 6 mm.) wide, the pods smooth with almost ligneous valves. It was endemic in rock fissures on the mountains. The only other species in Cyprus is *B. Tourfortii* Gouan on sandy seashore.

In careful genetic experiments by Moldenhauer (1927), crosses between wild and cultivated forms of *Brassica* all gave negative results. Three crosses between cultivated forms succeeded. In the cross *B. oleracea capitata*

[1] No numbers are given.

[2] In Mém. Herb. Boiss. No. 18:90. 1900.

♀ × *B. oleracea gemmifera* ♂ (cabbage × Brussels sprouts) the results were similar to those of Kristofferson and of Malinowski. The F_1 produced no lateral buds and no head, the leaves being loosely arranged, large and fleshy, like those of cabbage but with long petioles on a slender stem.

In F_2 segregation took place, some plants being exactly like cabbage, others like Brussels sprouts. There were also new forms, e.g., chou fourrager (kale?) with a long stem and loose leaves in a rosette, or a short stem and pendant leaves (a new type). *B. oleracea caulorapa*[3] (kohlrabi) × *B. o. gemmifera* (Brussels sprouts) gave a uniform F_1 of 17 plants. The stem was like kohlrabi but not oval, the leaves were many with axillary buds, as in Brussels sprouts, but they were mostly near the top of the stem. In form the leaves resembled Brussels sprouts, but their petioles were longer. The F_2 obtained by selfing and bagging was very variable but very few reverted to the parent types. As regards axillary buds, three types were produced: (a) plants with lateral buds, as in Brussels sprouts, 61; (b) plants with very small lateral buds, 8; (c) plants without lateral buds, 44. This was interpreted as a 9:1:6 ratio. One type was a loose-headed cabbage on a stalk, others were transitional to no head. As Brussels sprouts were a late development, the head cabbage can hardly have been derived from a cross between it and kohlrabi.

Pease (1926), in a later study of kohlrabi, concluded that it is probably one of the oldest cultivated varieties. It was known to Pliny as *Pompeianum*. It was described by Matthiolus and in the 16th century herbals. Gerarde states that it is grown in Italy, Spain and Germany. Crosses were made with thousand-headed kale, broccoli, cabbage, savoy, curly kale and Brussels sprouts. The "bulb" on the stem of kohlrabi was found by Pease to depend on three multiple factors, one of which was shown to be linked with a factor, D. The purple color of blue kohlrabi was due to two complementary factors, D and △.

Allgayer (1928) made reciprocal crosses between Rotkohl (*B. oleracea capitata rubra*) and Grünkohl (the green variety) and concluded that head formation in cabbage is due to a main factor, K, and three subsidiary factors, K_1, K_2 and K_3, producing equal effects, as against the 2-factor theory of Pease. Kohlrabi was found to be homozygous for the head-forming factor, K_3, Rotkohl having the factors K, K_1 and K_2. Crinkling of the leaves (in Grünkohl) was due to four dominant equivalent factors, W_1, W_2, W_3, W_4. Anthocyanin was the result of a dominant factor P (= Kristofferson D), the heterozygous condition producing red veins, the homozygous a red surface to the leaf. Head formation was "correlated" with scarcely crinkled leaves and with winged petioles, probably with crossing-over. Strong crinkling was similarly linked with winged petioles. P and K were linked, with

[3] Also classed as var. *gongylodes*.

20% crossing-over, and linkage between K factors and crinkling was also incomplete. Axillary shoots (*Achselsprossen*) were due to a recessive factor *a*. In the F_1 and F_2 of these crosses there were also 1–10% poorly developed plants (*Kümmerlichen*). In the cross Rotkohl × Kohlrabi, there was low germination and small size in F_1, low fertility in F_1 and F_2. The long stem of Rotkohl was produced by a dominant factor, L, and probably another factor, the thick stem of Kohlrabi being due to a dominant factor, B. L and B were independent, L being linked with K_1 or K_2 and B with K. The two linkage groups of genes were then as follows: 1st linkage group: K (heading), P (= D) red color, S_1 (= E and P) petiole, W (Pease) leaf width, W_1 or W_2 and B (stem broad); 2nd linkage group, K_1, W_2 or W_3, L(= T Pease) and probably S_2.

In the work of Moldenhauer kohlrabi (chou-rave) × cabbage (chou pommé blanc) confirms the results of Malinowski. The F_1 had no heads like cabbage, but the leaves were loose, very large and fleshy, the stem much thicker than cabbage but short like kohlrabi. The stem was red, the leaves green with red veins. The segregation in F_2 produced some plants nearly like the parent types, the rest intermediate. The crosses *caulorapa* × *gemmifera* and *capitata* × *gemmifera* both produce some *chou fourrager* (*B. oleracea acephala* DC.[4] var. *vulgaris*) in F_2 apparently a form of kale which may be ancestral to Brussels sprouts.

Allgayer (1928) also made the cross, Rotkohl × Kohlrabi. He found the seed germination low in F_1 and the later generations low in fertility. The long stem of Rotkohl was due to a dominant factor, L (T of Pease), and the thick, fleshy stem of Kohlrabi to a dominant factor, B, these two belonging to the different linkage groups. An important study of Brassica abnormalities and their inheritance, by Kondo and Issiki (1933), has not been available for examination.

It may be mentioned here that in crosses between *B. napus* (turnips) and *B. rapa*[5] (swedes) by Kajanus, continued by Hallquist (1915), significant results were obtained. In *B. napus*, white × yellow flesh gave a white F_1 with 15:1 segregation in F_2. As *B. napus* is an amphidiploid (U, 1935, Sikka, 1940), the presence of some duplicate factors may be expected. White × yellow flesh in swedes indicated one dominant factor for white. In both species flesh-color of the roots is correlated with flower color, the white-fleshed roots having citron flowers and yellow-fleshed orange flowers.

[4] Var. *acephala* = collards.

[5] *B. rapa* is perhaps best considered as a var. of *B. campestris*. The former includes the edible turnip and biennial turnip-rape; the latter applies to wild turnip *B. tournefortii* Gouan) and annual turnip-rape (*B. campestris* var. *annua*). Biennial turnip-rape, used for oil and bird-seed, is classed as *B. campestris* var. *autumnalis* DC. The garden turnip has apparently run wild in some parts of the U.S.A. and probably also in Europe. Makino (1932) has described 15 varieties of *B. campestris* which are grown as vegetables in Japan and one form which is found growing wild.

Onno (1933) made a study of the wild forms related to *B. oleracea* in many local herbaria, mainly in Italy and Vienna. They all grow on rocky areas near the coast or on islands. The Mediterranean region, where many species of *Brassica* grow, he regarded as the centre of origin of the group. Onno ranks the forms on the Atlantic coast of Europe and the North Sea Coast as merely a subspecies of *B. sylvestris*, while Ascherson held the improbable view that the forms on the coast of England and on Heligoland were derived from cultivated *B. oleracea* run wild, the spontaneous forms being confined to the Mediterranean.[6]

Onno recognizes two main species, (1) high-growing *B. sylvestris* (L.) Mill. with lyre-form or lyrate-divided rosette leaves, (2) the smaller *B. cretica* Lam. with lyre-form and undivided rosette leaves (*B. oleracea* being regarded as a collective species embodying all the Mediterranean and Atlantic forms). Both of Onno's species have subspecies and geographic varieties; and both have an endemic form with much thicker pods, and seeds in two rows as a result of broadening of the replum. *B. Hilarionis* Post of Cyprus is thus separated from *B. cretica* mainly by its very broad pods and *B. macrocarpa* Guss. in Sicily is similarly distinguished from *B. sylvestris*. *B. cretica* is recognized from Syria, Crete, the Aegean Archipelago, Greece, Sardinia, Corsica and Tunis, having three subspecies, *insularis*, *atlantica* and *cretica*.

The subspecies *incana* and *villosa* are excluded from *B. oleracea* by O. E. Schulz and treated as species, but Onno regards them only as forms. *B. balearica* Pers. from Mallorca and *B. scopulorum* Coss. and Durand from the coast of Algeria are endemic species, smaller in all their parts and with petiolate stem-leaves. Flower color ranges from yellow to white.

Against the assumption that *B. oleracea* in Western Europe has run wild from cultivated ancestors, Onno considers the uniformity of "ssp. *sylvestris*" in comparison with the great variety of cultivated forms. Also in Heligoland, forms which have run wild, such as *B. nigra*, *B. napus*, *Raphanus raphanistrum* and *Sinapis arvensis*, produce no ripe fruits whereas *B. sylvestris* fruits abundantly. *B. oleracea* has been naturalized on coastal rocks in New Zealand.

Onno recognizes *B. cretica*, *B. Hilarionis*, *B. sylvestris*, *B. macrocarpa* Guss. (a parallel form to *B. Hilarionis*, probably developed from *B. sylvestris* as *B. Hilarionis* has from *B. cretica*) in Sicily and the Aegean. The flower color varies from white to yellow. *B. balearica* on Mallorca and *B. scopulorum* (glabrous, no rosette leaves, near *balearica*) in Algeria, are both smaller in all their parts and have petiolate stem-leaves. Of *B. sylvestris* Onna recognizes 5 ssp., *incana* (in E. Sicily), *Robertiana* (on the coasts of S. France and N. Italy), *sylvestris* (Atlantic coast of Europe), *villosa*

[6] Ehlers (1920) gave an account of the wild cabbages of Heligoland.

and *rupestris* (both in Sicily). Of *B. cretica*, ssp. *insularis* is in Corsica and Sardinia, ssp. *Cazzae* mainly on islands in the Adriatic, ssp. *nivea* in the Aegean islands and Crete. If Italy was the original source of cabbage-like plants one would like to see a careful comparison of Italian forms with those from the Atlantic coast. Little appears to be known of the species on the Black Sea coast. Litardière and Simon (1921) described *B. oleracea* subspecies *insularis* var. *Ayliesii* in Corsica, differing from var. *corsica* in its shorter stems, smaller flowers, sepals and petals yellow, petals unguiculate, panicle less lax.

In an account of the Rif flora, Emberger and Maire (1927) list *B. fruticulosa* Cyr. ssp. *Cossoniana* (Boiss. et Reut.) Maire growing on arable clay soil at 1,000 m. altitude. They describe a new species, *B. rifana* Emb. & Maire, which differs in being perennial or biennial and in various other features. It grows among calcareous rocks in the Azrou mountains at an altitude of 1880–2000 m. In studies of the Moroccan flora, Maire (1929) describes a new variety *B. saxatilis* (Lamk) Amo ssp. *nudicaulis* (Lag.) O. E. Schulz var. *purpurascens* Humb. et Maire. It differs from var. *berberica* Lit. et Maire in having purple-brown petals, smooth pinnatifid leaves, siliquae 4 cm., and from var. *maritima* (Rouy) O. E. Schulz in its petals and sepals. It grows on the Atlantic coast on calcareous subalpine rocks and in the mountains up to 2,700 m. A new species, *B. Desnottesii*, was described by Emberer and Maire (1929) having long stems clothed with leaf vestiges, the leaves submembranaceous. It differs from *B. saxatilis* ssp. *africana* (O.E.S.) Maire in having glabrous peduncles and short siliquae, much inflated, as in Eruca. None of these appear to resemble *B. oleracea*.

In an evaluation of the taxonomic characters of the Brassica cultigens, Sun (1946) has drawn up keys to the species and varieties. He points out parallelisms between certain species in many characters, and recognizes *B. nigra* Koch, *B. carinata* Braun, *B. oleracea* L. (6 vars.), *B. napus* L. (2 vars.), *B. campestris* L. (2 vars.), *B. chinensis* L. (6 vars.), *B. juncea* Coss. (9 vars.). *Sinapis alba* L. is not considered a Brassica and *B. pekinensis* Rupr. is merged with *B. chinensis* L. The 10-chromosome Brassicas are divided into two groups: (1) Oriental (*B. chinensis*) in China and Japan; (2) Western, mainly European. He thinks the Western forms should all be known as *B. campestris* (= *B. rapa*), but this is an undesirable degree of "lumping."

The pyramiding of chromosome numbers in the genus through amphidiploidy has been remarked upon elsewhere (Gates, 1950). Nagai and Sasaoka (1930) counted the chromosomes in 13 species of *Brassica*, the haploid number being 8 in *B. nigra* Koch, 9 in *B. oleracea* and *B. arvensis* Rabh., 10 in *B. rapa* L., *B. chinensis* L., *B. pekinensis* Rupr., *B. campestris*

L., *B. narinosa* Bailey and *B. nipposinica* Bailey, 12 in *B. alba* Rabh., 18 in *B. juncea* Coss and *B. napiformis* Bailey, 19 in *B. napus* L. Thomas and Crane (1942, 1943) counted the chromosomes in all the cultigens of *Brassica* grown in England. They found 2n = 18 in kales, cabbages, cauliflower, broccoli, savoy, kohlrabi, Brussels sprouts and rosette colewart, 2n = 20 in white and yellow turnips and turnip rape, 2n = 38 in white and yellow swedes, swede rape and the kales known as Hungry Gap, Asparagus and Late Rape. These amphidiploids with 38 chromosomes have the turnips as one parent, but it is not clear which of the 18-chromosome forms is the other parent. They found that the kales cross readily with cabbage, cauliflower and Brussels sprouts, but the hybrids are sterile except in the rare cases when chromosome doubling takes place. This will produce a new amphidiploid with 56 chromosomes, and some of these may be valuable as vegetables of new type.

In an examination of the chromosomes of some Italian Brassicas, Netroufal (1927) grew *B. montana* Pourret from seeds, as well as *B. oleracea* from Heligoland and cultivated cabbage for comparison. He thinks that Kopfkohl and Wirsingkohl as well as the Blätterkohlsorten were derived from the north Italian *B. montana* while *kohlrabi* came from *B. rupestris* further south. Shimotomai (1925) showed that the three cultivated vars. *capitata*, *acephala* and *gemmifera* of *B. oleracea* all have n = 9 chromosomes, whilst in *B. campestris*, *B. rapa*, *B. chinensis*, *B. pekinensis* and *B. japonica* n = 10 and in *B. juncea* (= *B. cernua* Hemsl.) n = 18.

Musil (1948) shows that the seeds of *Brassica* can be distinguished by their surface markings. A few species have yellow or straw-colored seeds, but in most species they range from brown to black. Under a low magnification reticulations and stipplings appear, the type of markings furnishing diagnostic characters. The reticulation thus furnishes in many cases a reliable clue to the species. But these features are minute and show some variation.

The widespread self-fertility in Brassica crops necessitates the cultivation of seed stocks in separate areas, to prevent seed contamination. Davey (1939) points out that while the two mustards—*B. nigra* (n = 8) and *Sinapis alba*[7] (n = 12)—are incompatible, all the cultigens of *B. oleracea* will intercross. *B. rapa* × *B. napus* will produce vigorous hybrids although in *B. rapa* (including turnips and turnip-like rapes) n = 10 while in *B. napus* (swedes, swede-like rapes and certain kales) n = 19. The name *B. napobrassica* Mill. has also been applied to the swede and is recognized by Bailey. The swede turnip is commonly known as rutabaga and has been classified as *B. napus* var. *napobrassica* (L.) Reichb. It has n = 19 chromosomes.

[7] Wheeler (1938) finds that the earliest name for *B. alba* (L.) Rabh. is *B. hirta* Moench.

Howard (1940) points out that since cultigens with 2n = 38 chromosomes belong to *B. napus*, while *B. campestris* has 2n = 20, the cultigens *sarson* and *toria* in India, which have 2n = 20, should be treated as varieties of the latter species. Passerini (1928) cultivated from several parts of Italy the oil-producing cultigens which go under the names Ravizzone and Colza. He concluded that the former should be called *B. campestris* L. var. *oleifera* DC. and the latter *B. napus* L. var. *oleifera* DC.

Reverting to the history of the cultigens which are generally supposed to be derived from *B. oleracea*, DeCandolle concluded on philological grounds that cultivation of wild Brassicas began in several places in Europe. Schiemann (1932), in tracing the later history, found that the Greeks used them little for food. They knew only three kinds, but made a decoction from the seeds which was used as medicine. Columella, in the 1st century B.C. named 14 varieties, but Cato knew only three kinds, one being green Blattkohl. Pliny described 7 or 8 kinds, some of which were like the modern ones, but others are lost. A forerunner of the cabbage dates from Roman times. Charlemagne knew only two kinds, *caulos* and *ravacaulos*. One of these was kohlrabi, but as already mentioned, it was known much earlier. Broccoli came late, but cauliflower and broccoli are both mentioned by Bauhin.

By the 12th century more varieties were available, probably partly from mutations and partly from crossing, and the Herbals record many varieties. Schiemann (1932) concludes that most of these cultigens originated in the Mediterranean region, especially in Italy. North of the Alps were produced Kopfkohle (cabbages), Wirsing (savoy) and Rosenkohl, the last being the youngest form. It combines shoot formation with head-building and crinkled leaves. Brussels sprouts appeared in Belgium in 1785 and spread slowly in the 19th century. Axillary shoot formation was a feature of some old Roman varieties, but this was lost when selection took another direction. Blumenkohl is believed by Becker to be derived from *B. oleracea* var. *cretica*. Seeds of this form from Crete have long been sown in Italy, and later in Germany and Switzerland.

From what is already known of the history of cultivated Brassicas, it is clear that many new types have appeared at different times in the last two thousand years and that old types have undergone great transformations. It has been pointed out elsewhere (Gates, 1950) that some of the weeds of cultivated crops, notably those associated with flax cultivation, have undergone rapid evolution, forming new species within historical time. Similarly it has been shown (Salaman and Hawkes, 1949) that the wild potato plant, *Solanum andigenum* from the Andes, has evolved into *S. tuberosum*, the domestic potato, in perhaps two centuries under cultivation in Europe. This involved marked changes in both tubers and leaves,

and also in physiology in adaptation to European climatic conditions. *S. andigenum* is a short-day plant forming many small tubers. *S. tuberosum* is a long-day plant with larger leaves and quite different leaflet characters, less bushy habit and bearing few large tubers. This fundamental reformation of the potato plant may have seriously begun as late as 1710. Modern potatoes still retain vestiges of *S. andigenum* characters which can be revived by selection in the reverse direction.

It has also been pointed out elsewhere (Gates, 1950) that visible differences in the chromosomes have arisen through selection, e.g. of the sugar beet from the wild beet. These must have arisen through translocations and other changes within the chromosomes. It has similarly been shown (Bailey, 1949) that certain morphological differences in the chromosomes distinguish *Trillium erectum* in Tennessee and in Canada. This very uniform species is taxonomically identical in phenotypic characters in the two areas, but (using identical cytological techniques) the primary constriction, especially in the C and D chromosomes, differs in position in Tennessee and Canada. Translocations and inversions are also known to have occurred in various populations of Drosophila species.

By way of summary it may be said that the numerous Mediterranean species of *Brassica*, many of them closely related, afford much more variety for the origin of cultigens than has been commonly supposed. Further evidence could doubtless be obtained by growing some of these species. In the long period since culture of wild Brassicas began, perhaps in the Neolithic, many wild forms have probably been introduced into cultivation. The resulting cultigens have also had a more complicated history than generally realized, since many of them will cross, so that mutation and hybridization have both been involved in the production of new cultigens.

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Literature Cited

Allgayer, H. 1928. Genetische Untersuchungen mit Gartenkohl (*Brassica oleracea*) nach Kreuzungsversuchen von Richard Freudenberg. Zeits. Abst. u. Vererb. **47**: 191–260.

Bailey, P. C. 1949. Differential chromosome segments in *Trillium erectum*. Bull. Torrey Club **76**: 319–336.

Blaringhem, L. 1925. Sur le chou vivace (*Brassica oleracea* L. var. *suffructicosa*) du Cap Blanc Nez, près Wissant (Pas-de-Calais). Trav. Stat. Zool. de Wimereux. **9**: 1–10.

Cavara, F. 1890. Di una rara specie di *Brassica* dell'Appenino emiliano. Malpighia **4**: 124–131.

Crane, M. B. 1943. The origin and relationships of the Brassica crops. Jour. Roy. Hort. Soc. **68**: 172–174.

Davey, V. M. 1939. Hybridization in Brassica and the occasional contamination of seed stocks. Ann. Appl. Biol. **26:** 634–636.

Ehlers, K. 1920. Der wilde Kohl auf Helgoland. Kosmos **17:** 45–48.

Emberger, L. and Maire, R. 1927. Spicilegium Rifanum. Mém. Soc. Sci. Nat. Maroc 59.

————. 1929. Matériaux pour la flore Marocaine. Mém. Soc. Sci. Nat. Maroc **22:** Fasc. 1.

Gabriel, C. 1928. Sur les caractères acquis par *Brassica Robertiana* cultivé. Compt. Rend. Soc. Biol. **98:** 777–782.

Gates, R. R. 1950. Wild cabbages and the effects of cultivation. Jour. of Genetics. (In press).

Hallquist, C. 1915. Brassica-Kreuzungen. Bot. Not.: 97–112.

Holmboe, J. 1914. Studies on the vegetation of Cyprus. Bergens Mus. Skrifter, Ser. 2, No. 2, pp. 344.

Howard, H. W. 1940. The nomenclature of Brassica species. Current Sci. **9:** 494–5.

Kondo, M. and Issiki, S. 1933. Über das Erscheinen und die Erblichkeit der Abnormitäten bei der Brassica-Züchtung. Landw. Stud. **20:** 155–183.

Litardière, R. de and Simon, E. 1921. *Brassica oleracea* subsp. *insularis* var. *Ayliesii*. Bull. Soc. Bot. Fr. **68:** 88–92.

Maire, R. 1929. Contributions à l'étude de la flore de l'Afrique du Nord. Mém. Soc. Sci. Nat. Maroc **21:** Fasc. 15.

Makino, T. 1932. Brassica in the Japanese flora. Jour. Jap. Bot. **8:** 7, 20, 24.

Moldenhauer, K. 1927. Recherches sur certains croisements intéressants du genre Brassica. Bull. Internat. Polon. Sci. et Lettr. Ser. B: 1049–1071.

Musil, A. F. 1948. Distinguishing the species of *Brassica* by their seed. U. S. Dept. Agr. Misc. Publ. No. 634.

Nagai, K. and Sasaoka, T. 1930. The number of chromosomes in the cultivated Brassica. Jap. Jour. Genetics **5:** 151–158.

Netroufal, F. 1927. Zytologische Studien über die Kulturrassen von *B. oleracea* L. Österr. Bot. Zeits. **76:** 101–115.

Onno, M. 1933. Die Wildformen aus dem Verwandschaftskreis "*B. oleracea* L." Österr. Bot. Zeits. **82:** 309–334.

Passerini, N. 1928. Sulle specie di "Brassica" cui corrispondono i nomi volgari di "Ravizzone" e di "Colza". Nuovo Giorn. Bot. **35:** 376–380.

Pease, M. S. 1926. Genetic studies in Brassica. II. The Kohl rabi. Jour. Genetics **17:** 253–267.

Richharia, R. H. 1937. Cytological investigations of *Raphanus sativus, Brassica oleracea,* and the F_1 and F_2 hybrids. Jour. Genetics **34:** 19–44.

Salaman, R. N. and Hawkes, J. G. 1949. The character of the early European potato. Proc. Linn. Soc. Lond. **161:** 71–84.

Schiemann, E. 1932. Entstehung der Kulturpflanzen. Handbuch d. Vererbwiss. **3:** 1–377.

Shimotomai, N. 1925. A karyological study of *Brassica*. Bot. Mag. Tokyo **39:** 122–127.

Sikka, S. M. 1940. Cytogenetics of Brassica hybrids and species. Jour. Genetics **40:** 441–509.

Sun, V. G. 1946. The evaluation of taxonomic characters of cultivated Brassica with a key to species and varieties. Bull. Torrey Club **73:** 244–281; 370–377.

Thomas, P. T. and Crane, M. B. 1942. Genetic classification of Brassica crops. Nature **150:** 431.

U, N. 1935. Genome-analysis in *Brassica* with special reference to the experimental formation of *B. napus* and peculiar mode of fertilization. Jap. Jour. Bot. **7:** 389–452.

Wheeler, L. C. 1938. The names of three species of *Brassica*. Rhodora **40:** 306–309.

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A FOSSIL OSMUNDACEOUS TREE-FERN FROM BRAZIL

HENRY N. ANDREWS, JR.

About a year ago a specimen of a silicified tree-fern from Brazil was received from Dr. Ney Vidal of the Museu Nacional in Rio de Janeiro. It consists of a nearly complete transverse slice of the trunk of the tree (see plate), petrified with silica and traces of other minerals which lend a very colorful appearance to the polished surface. Most of the softer tissues have been completely replaced by the petrifying minerals, yet the general organization of the trunk and the vascular tissue are sufficiently intact to allow its identification with the Osmundaceae, and it possesses certain characters which seem to render it distinct from previously described species of the genus *Osmundites*. In its large size it is particularly unique, being exceeded in this respect by only one other species.

The specimen measures 7 mm. in thickness and consists of a stem 8 cm. in diameter (fig. 3) enclosed in a sheath of roots which attain a maximum thickness of 4.5 cm. The xylem cylinder, with an average outside diameter of 26 mm., is a typical Osmundaceous one composed of about 22 segments. Outside of this is a thick cortex containing a considerable number of departing leaf traces. Within it is a pith region 16 to 17 mm. in diameter which contains no preserved tissue.

The xylem segments are divided by the frequent departure of the leaf traces (fig. 1) and there is some evidence that additional divisions occur. The larger segments are as much as 50–60 cells in radial thickness although the diameter of the individual tracheids compares very closely with that of a modern *Osmunda regalis* or *O. Claytoniana*. The xylem ring is completely enclosed by a thin red-stained band which can with little doubt be identified as the endodermis. This tissue likewise encloses the departing leaf traces and its continuity is broken only at such points. This is clearly indicated in the text figure where the ring, at the particular level shown, is thus broken at four places.

The cortex is a broad zone of about 27 mm. radial thickness and is preserved only at its outer periphery. Of particular interest here is the organization of the numerous leaf traces. Immediately upon their departure from the stele they are open C-shaped structures (text figure) and in passing through the cortex the traces increase appreciably in size becoming strongly V-shaped at the periphery while the arms at this point are very slightly involuted. A distinctive feature of the trace lies in the presence near the ends of the arms of a small "island" in which the tracheids are lacking

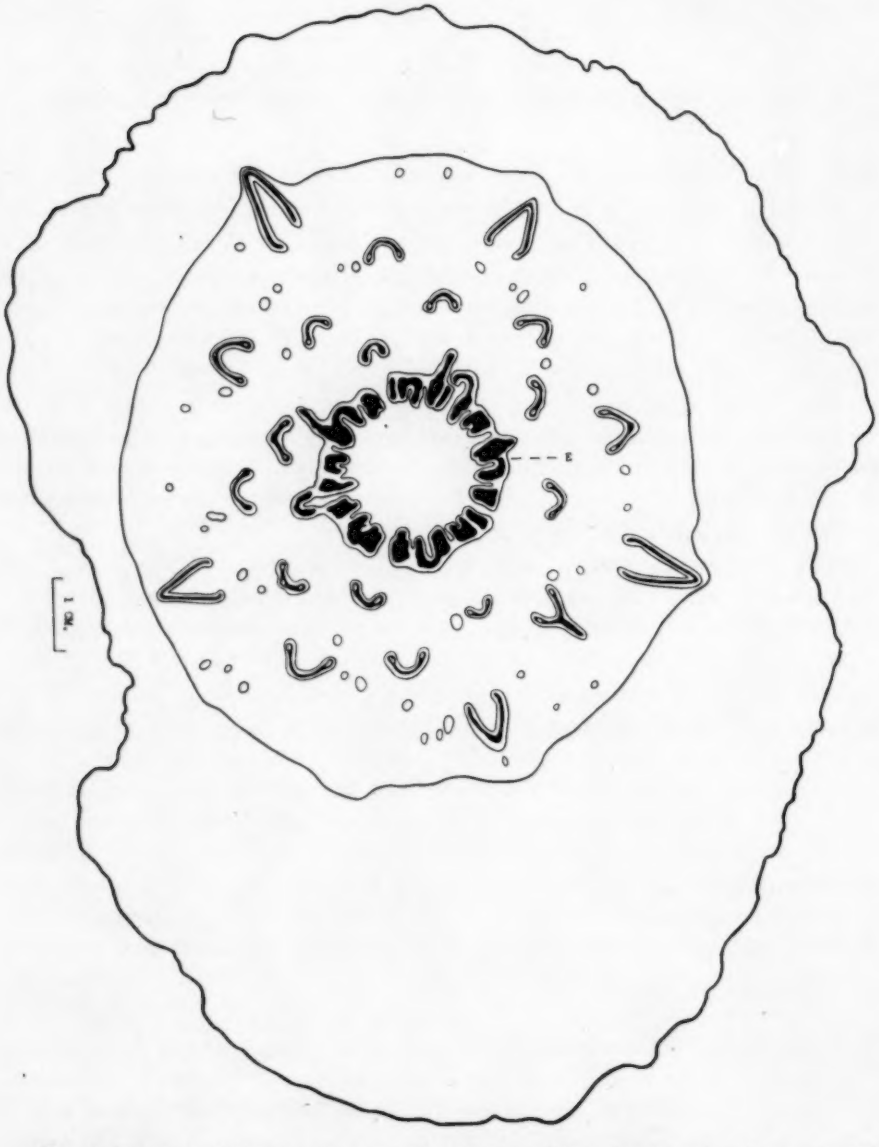

FIG. 1. Diagram of the transverse section of *Osmundites braziliensis*. The segmented stele is shown in heavy black; the thin line (E) immediately surrounding the stele or portions thereof represents the endodermis. The distinctive anatomy of the leaf traces is shown in their passage through the cortex. Broad outer area represents the root zone.

(fig. 4). Since this is a constant feature of the traces except at the extreme periphery of the cortex it seems apparent that it represents an area formerly occupied by parenchymatous tissue which was less resistant to decay.

The stem proper is enclosed by a mantle of roots measuring nearly two inches at the thickest point. It appears probable that a portion of this mantle has been lost. These roots may be noted in the stem to be departing directly from the stele as well as from the petiole traces. Their departure

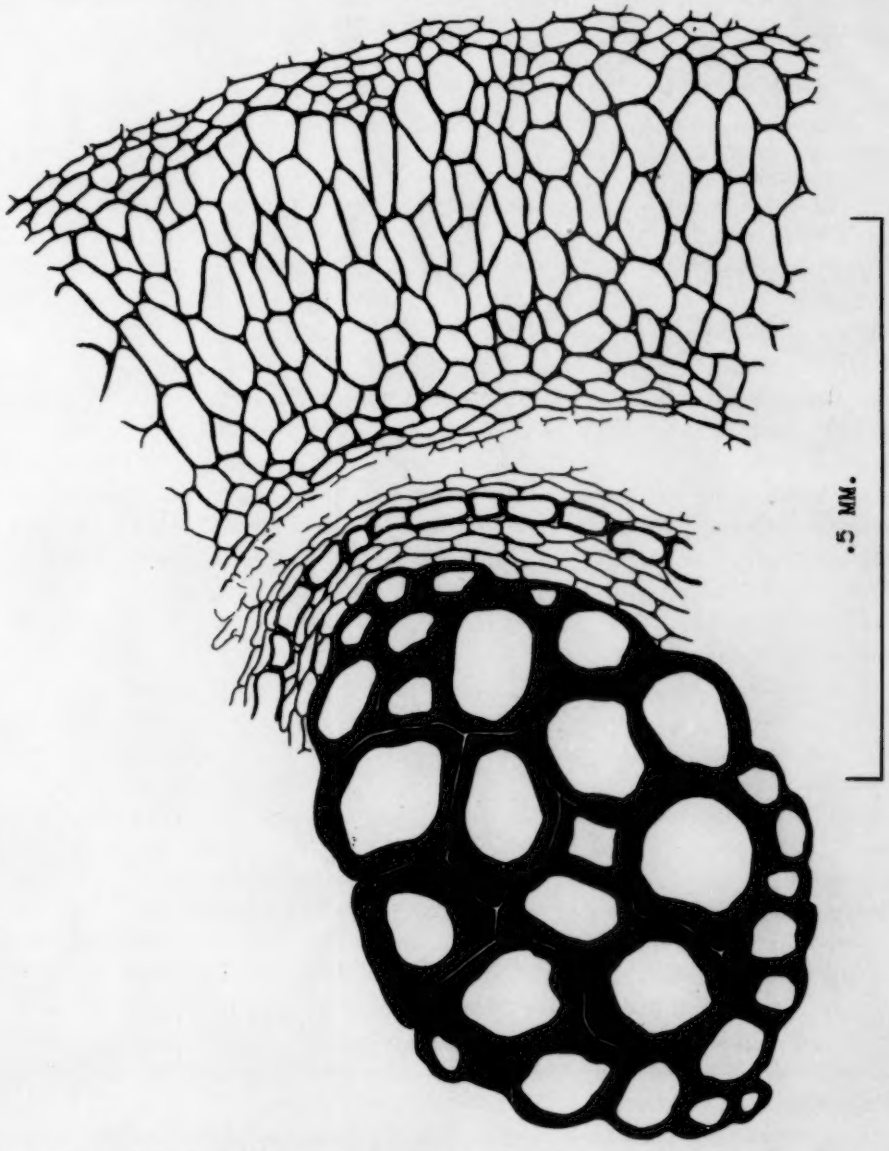

FIG. 2. Representative portion of a root highly enlarged, showing the broad outer parenchymatous cortex and diarch stele.

from the stele apparently formed a rather acute angle with the latter since they are seen for the most part in transverse or nearly transverse sections. After leaving the outer cortex the roots (figs. 2, 3) followed a downward course nearly parallel with the stem and in view of considerable variation in size it would appear that some branching took place, this being also a contributing factor to the thickness that the mantle attained.

Diagnosis: *Osmundites braziliensis* sp. nov.

An arborescent plant; pith probably parenchymatous; stele with outside diameter of 26 mm., composed of about 22 segments; leaf traces at point of departure open C-shaped becoming V-shaped toward the periphery of the cortex, ends of the traces with an "island" in the tracheids probably occupied in life by parenchymatous tissue.

Type specimen: No. 5035, paleobotanical collections of the Henry Shaw School of Botany.

Origin: Collected in "municipio de Rio Pardo, Estado do Rio Grande do Sul", Brazil. Thought to be of Permian age.

The only information that the present author has concerning the origin of this fossil is the locality as given above and the statement that the formation from which it came is thought to be of Permian age. This seems very unlikely on the basis of what is known of the age and structure of other members of the fossil Osmundaceae. Judging from what we know of the distinctly more primitive genera, such as *Zalesskya* and *Thamnopteris* from the Permian, and the numerous more advanced Mesozoic species, it seems very unlikely that the beds from which *O. braziliensis* was derived are older than Jurassic.

Of the assemblage of fossils assigned by Kidston and Gwynne-Vaughan (1907–16) to the Osmundaceae the only one with which a reasonably close comparison may be drawn with *Osmundites braziliensis* is *O. Carnieri* Schuster. The original description by Schuster appeared in 1911 and a briefer account was included by Kidston and Gwynne-Vaughan in the fifth part (1916) of their monographic treatment of the family. As far as size is concerned the two are rather close, the stem diameter of *O. Carnieri* being 90 mm. and that of *O. braziliensis* 85 mm. The former has, however, a somewhat larger stele, being 35 mm. in outside diameter and composed of up to 35 segments while the stele of the Brazilian species is about 26 mm. in diameter and with some 26 segments. While the differences of stelar size and segmentation in themselves may hardly justify the segregation of a new species the further differences in leaf trace structure seem to justify this taxonomic treatment.

In comparing Schuster's figures with the Brazilian specimen the latter displays a much more pronounced transition from an open C-shaped bundle near the point of departure of the stele to the strongly developed V-shape

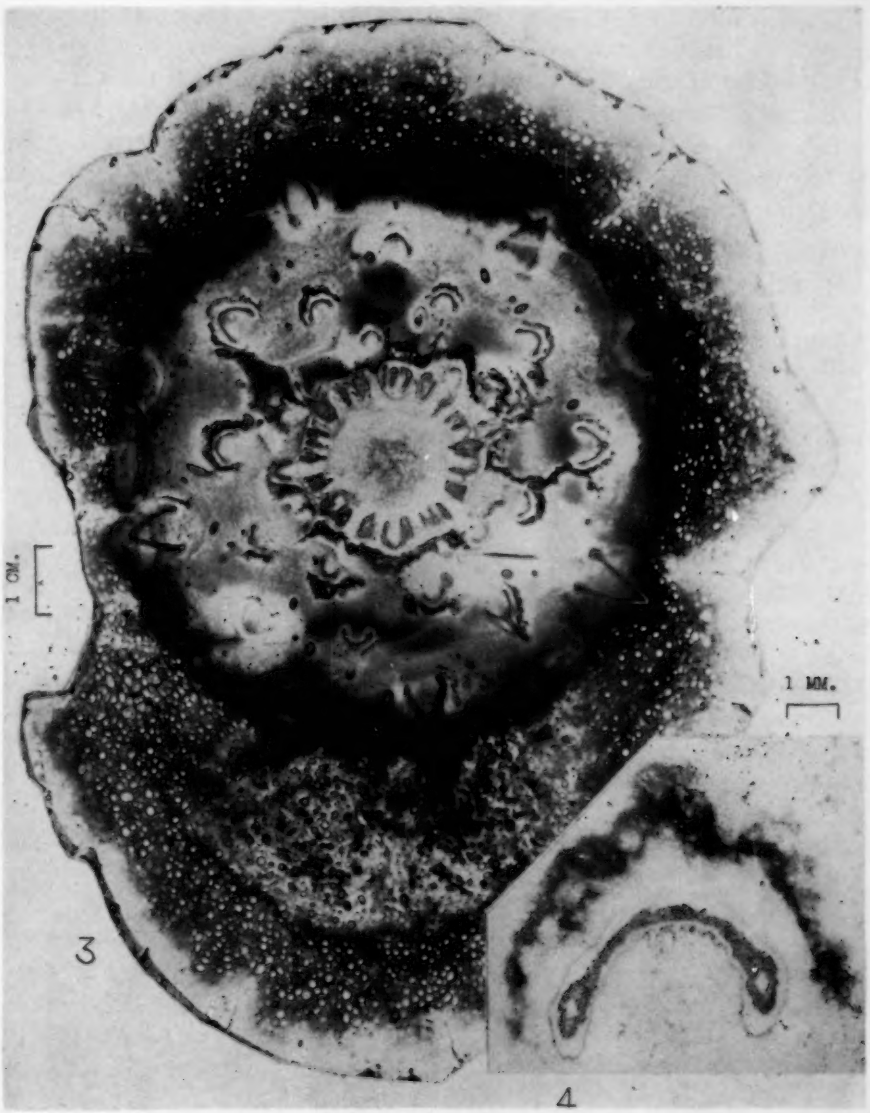

FIG. 3. A photograph of the polished transverse surface of *Osmundites braziliensis* Andrews.

FIG. 4. A leaf trace enlarged.

near the periphery of the stem. In *O. Carnieri* the trace is more deeply curved at the point of departure and retains this more uniformly throughout its course. There is, moreover, no indication of the "parenchymatous loop" near the tip ends of the trace arms as in the case of *O. braziliensis.*

The contrast with other species of *Osmundites*, at least as far as size is concerned, is most striking. When compared with the Jurassic *O. Dunlopi* or the Eocene *O. Dowkeri*, where the stelar diameter in both cases is about 5 mm., the difference is enormous; and the contrast with such native modern species as *Osmunda regalis* or *O. cinnamomea* is even more extreme.

The wide range in time over which species of *Osmundites* are known when viewed in conjunction with the variability in structure of the siphonostele strongly suggests a group of greater taxonomic diversity than a single genus. However, from the Jurassic *O. Dunlopi* with its nearly continuous xylary ring to somewhat more recent species such as *O. Kolbei* in which the cylinder is segmented into some 56 strands, it is not possible to draw sharp segregating lines. Likewise the range in size, from species such as the Pliocene-Miocene *O. Schemnitzensis* with a stele of 4 mm. diameter to *O. Carnieri* with one of 35 mm., is more or less continuous.

Such representatives as *O. Carnieri* and *O. braziliensis* are noteworthy in view of the size of plant they represent for they must have been impressive tree-fern elements in the vegetation of their day, quite in contrast with the rather low-growing species of *Osmunda* so common in the eastern American woodlands today.

Acknowledgement: My sincere thanks are due to Dr. Ney Vidal for placing this specimen in my hands for description.

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Literature Cited

Kidston, R. and D. T. Gwynne-Vaughan. 1916. On the fossil Osmundaceae. Part V. Trans. Roy. Soc. Edin. **50**: 469–480.

Schuster, J. 1911. Osmundites von Sierra Villa Rica in Paraguay. Ber. Deuts. Bot. Ges. **29**: 534–539.

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BRAUN'S "FRAGMENTE" AND THE NOMENCLATURE OF THE CHARACEAE

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Rantzien and Olsen (1949) have submitted a proposal to the Committee on Nomenclature for the attention of the International Botanical Congress to be held in Stockholm during 1950, proposing that the starting-point for the nomenclature of the Charophyta be changed from Linnaeus 1753 to Braun 1883 [1882, cf. foot note]. Although the writer is prepared to present further specific evidence, the following general note may suffice to introduce basis for a counter opinion in this special case.

Alexander Braun's works on Characeae have probably been unequalled in scope by any other student of this group. Unfortunately, Braun died before his vast knowledge was assembled in a unified monograph. His unpublished notes and manuscripts as well as his published works were, however, assembled by Dr. Otto Nordstedt in the "Fragmente einer Monographie der Characeen" in "Die Abhandlungen der königliche Akademie der Wissenschaften zu Berlin (für 1882)": 1–211, pl. 1–7, 1883. This work, then, represents a compilation of Braun's opinions and works (coupled with parenthetical additions and a synopsis by Nordstedt) over a number of years, and thus such opinions are not always consistent. It may be considered the most important reference for this group, and all students are indebted to Braun and Nordstedt for the existence of such a cornerstone of knowledge. Even with our great admiration for this work, it is well to recognize it for just what it is, a source of information. However, the circumstances under which it was compiled have resulted in a number of features which greatly detract from the desirability of using this work as a basis of nomenclature. From among these features, a few are listed: (1) in a large proportion of the species treatments, various symbols instead of names of categories have been employed so that one can not detect whether Braun meant the various taxa to have the status of varieties, forms, or merely descriptive names; (2) the manner of outlining subspecific taxonomic groups often results in a confused treatment (e.g., cf. *Nitella acuminata* or *Chara gymnopus*); (3) a large number of subspecific forms are listed variously with and without descriptions, status, or types,, and thus it is difficult to decide and probably impossible for several workers ever to agree as to which have been validly published and adequately described; (4) whereas a very large number of specimens studied are cited, no selection

of type specimens is indicated. Although these inadequacies of precision are little or no cause for distraction to students seeking information or identifying plants, they render the "Fragmente" very unsuitable as a basis for nomenclature. Indeed, were it to be used it would have to be largely rewritten so as to be sufficiently systematic and precise for nomenclatorial purposes.

Because of these features, the writer is of the opinion that it would be far preferable to retain and recognize this work as the source of information that it is and not as a starting-point for nomenclature. If it were absolutely essential to have a new starting-point, which the writer doubts because of the relatively small group of plants concerned, Wallman's perhaps less authoritative but extremely systematically written work (1853) which contains descriptions and cites specimens (frequently types) would be preferable. Furthermore, through the excellent works and considerable effort already expended by such men as H. & J. Groves, Groves & Bullock-Webster, G. O. Allen, and J. Zaneveld, great strides have been made in bringing the nomenclature of the Characeae into accord with the international rules. Their painstakingly achieved results should not be discarded in favor of a change of questionable merit. Those who are particularly anxious for stability in nomenclature may be interested in the writer's forthcoming Index Nominarum Characearum which will be an attempt to index all known published names and their sources of original description. Armed with this index, future monographic work should be much simplified.

Botanists who are particularly anxious for such a change as proposed would do well to consult the mycologists with regard to the difficulties which have arisen through accepting Fries as the starting-point. In this regard, it would seem that Charologists by comparison may at present consider themselves fortunate that such a situation has not been forced upon them.

The present writer, then, suggests that the proposal for a new starting-point for the Characeae be withdrawn, or that serious notice of the difficulties which would arise from adopting the "Fragmente" be given this work before consideration by the Congress.

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Literature Cited

Braun, A. 1868. Die Characeen Afrika's. Monatsber. K. Akad. Wiss. Berlin (1867): 782–801, 873–944. (Reprinted and repaged consecutively from 782–872).

———— 1882[1]. Fragmente einer Monographie der Characeen. Nach den hinterlassenen Manuscripten A. Braun's herausgegeben von Dr. Otto Nordstedt. pp. 1–211, pl. 1–7. Dümmlers Verlag. Berlin. (Also in *Abh. K. Akad. Wiss. Berlin* (1882): 1–211, pl. 1–7. 1883).

Linnaeus, C. 1753. Species Plantarum, 2. Stockholm.

Rantzien, H. H. af, and Olsen, S. 1949. A suggested starting-point for the nomenclature of Charophyta. Svensk Bot. Tidskr. **43:** 98–106.

Wallman, J. 1853[1]. Försök till en systematisk uppställning af växtfamiljen Characeae. K. Vets.-Akad. Handl. (1852): 229–331. 1854.

(French translation by W. Nylander: Essai d'une exposition systematique de la famille des Characées. Act. Soc. Linn. de Bordeaux, ser. 3, **21:** 1–90. 1856).

[1] Dates of priority for these works are established as one year prior to the dates of publication of the respective journals, because of earlier issuance of separates. Thus, these dates are given here, and correct the dates given by the writer (Wood, Farlowia 3: 386–391, 1948). The date of 1882 of issue for the "Fragmente" has been confirmed by Mr. Oldman of the British Museum and Prof. Hartung of the Deutsche Akademie der Wissenschaften zu Berlin in letters to the writer.

BULLETIN OF THE TORREY BOTANICAL CLUB
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THE RELATION OF CERTAIN SOIL BACTERIA TO FRENCHING SYMPTOMS OF TOBACCO

ROBERT A. STEINBERG

It was suggested in a previous paper by the writer (1947b) that frenching of tobacco was caused by the action of diffusates from presumably nonpathogenic soil bacteria. Of the approximately sixty species and strains that were studied, two seemed most effective in causing an approximation of the symptoms of frenching in tobacco seedlings. These were *Bacillus cereus* Frankland and Frankland, and *Erwinia carotovora* (L. R. Jones) Holland. Seedlings of oriental Zanthi tobacco in aseptic culture displayed extreme narrowing or "strapping" of leaves when inoculated marginally (stab) in the nutrient agar. Seedlings grown in the presence of *B. cereus* also displayed reticular chloroses of leaves prior to strap-leaf formation, as in field plants. Contact between roots and bacteria was not required apparently and avoided experimentally. Roots of test plants appeared normal but were shorter and thicker particularly in the zone nearest the bacteria.

The assumption that the metabolic activities of an apparently harmless soil microorganism may be the primary cause of frenching is not inconsistent with other known facts. Bacteria in soil respond quickly to environmental stimuli. Timonin (1940), for example, has found that the number of bacteria in the rhizosphere of cultivated plants increased 7 to 71 times above that of control soils. Fungi increased 0.7 to 3.1 times. West (1940) reported that bacteria characteristic of the rhizosphere of tobacco and flax had more complex nutritional requirements than did those of control soils. The soils used by Wallace (1949) led to an opposite response as concerns nutritional types of bacteria. Such divergencies are to be expected since comparisons are based primarily on relative abundance and types of organic matter within and without the rhizosphere. The important factor consists in the possibility of an accumulation of organic matter in the rhizosphere to a degree sufficient to influence the types and number of bacteria present.

Materials and Methods. The experiments of the writer have been continued for the purpose of comparing the action of two strains of *B. cereus* and of *E. carotovora* under the influence of different commercial peptones in producing the symptoms of frenching. The presence of peptone in traces of about 200 p.p.m. is necessary to permit even limited growth of these bacteria to take place on a mineral agar. The Maryland Medium Broadleaf tobacco variety was used in place of the Xanthi. The former is less sensi-

tive (Xo.4) on the basis of the isoleucine effect, which can also be used to produce similar symptoms of abnormality in gross morphology.

The organisms employed were *B. cereus* strains number 342_1, and 305; and *E. carotovora*, strain number 171 of Dr. N. R. Smith. The seedlings were grown as usual on 50 ml. of mineral agar in 200 ml. pyrex Erlenmeyer flasks for six weeks. The temperature was 25° C. and the illumination about 500 foot candles provided by 3500° C. white fluorescent lamps. The flasks were inoculated after the seedlings had grown for one week. They were discarded five weeks later.

Experimental Results. A series of cultures on the standard nutrient agar containing 0.0002% bactopeptone were inoculated at ½, 1, and 1½ inch distances from the seedlings. *B. cereus* 305 was found to produce slightly earlier symptoms, than the 342_1 strain. It was also more effective at increased distances. Both strains resulted in the formation of reticular chloroses in the leaves of the seedlings, but only the 305 strain caused the formation of narrow leaves. *E. carotovora*, however, produced no symptoms of gross abnormality with seedlings of the Maryland tobacco. The less sensitive response of the Maryland variety to isoleucine was paralleled therefore by a similarly smaller response to the diffusion products of these microorganisms.

Another comparison of the two strains of *B. cereus* was made with 0, 50, 100, 200 and 500 p.p.m. of bactopeptone and proteose-peptone No. 4. Reticular chloroses appeared in the leaves of the seedlings with the 342_1 strain in 6 days with 200 p.p.m. of bactopeptone, and in 12 days with proteose-peptone. The former moreover resulted in formation of narrow leaves subsequently. The 305 strain caused reticular chloroses to appear in leaves of seedlings in 12 days with 200 p.p.m. of bactopeptone, and in 8 days with 200 p.p.m. of proteose-peptone. With 500 p.p.m. of proteose-peptone, however, the 305 strain caused the production of extreme frenching symptoms. Reticular chlorosis appeared in 8 days on the third leaf above the cotyledons, narrow leaf in 15 days on the fifth leaf, and strap leaf formation in 19 days.

The seedlings grown on 500 p.p.m. of proteose-peptone are shown in figure 1. The control seedling displays the normally shaped green leaves; and that inoculated with strain 305, the progressive alterations in gross morphology associated with frenching. The lower leaves are normal in shape, but develop a network chlorosis. Later formed leaves show a progressive decrease in width until a stage is reached in which there is practically no expansion of the leaf lamina. This extreme condition is accompanied by cessation of stem elongation. A still later stage that is not shown in the illustration is that in which many axillary buds start growth, but produce only strap-shaped leaves.

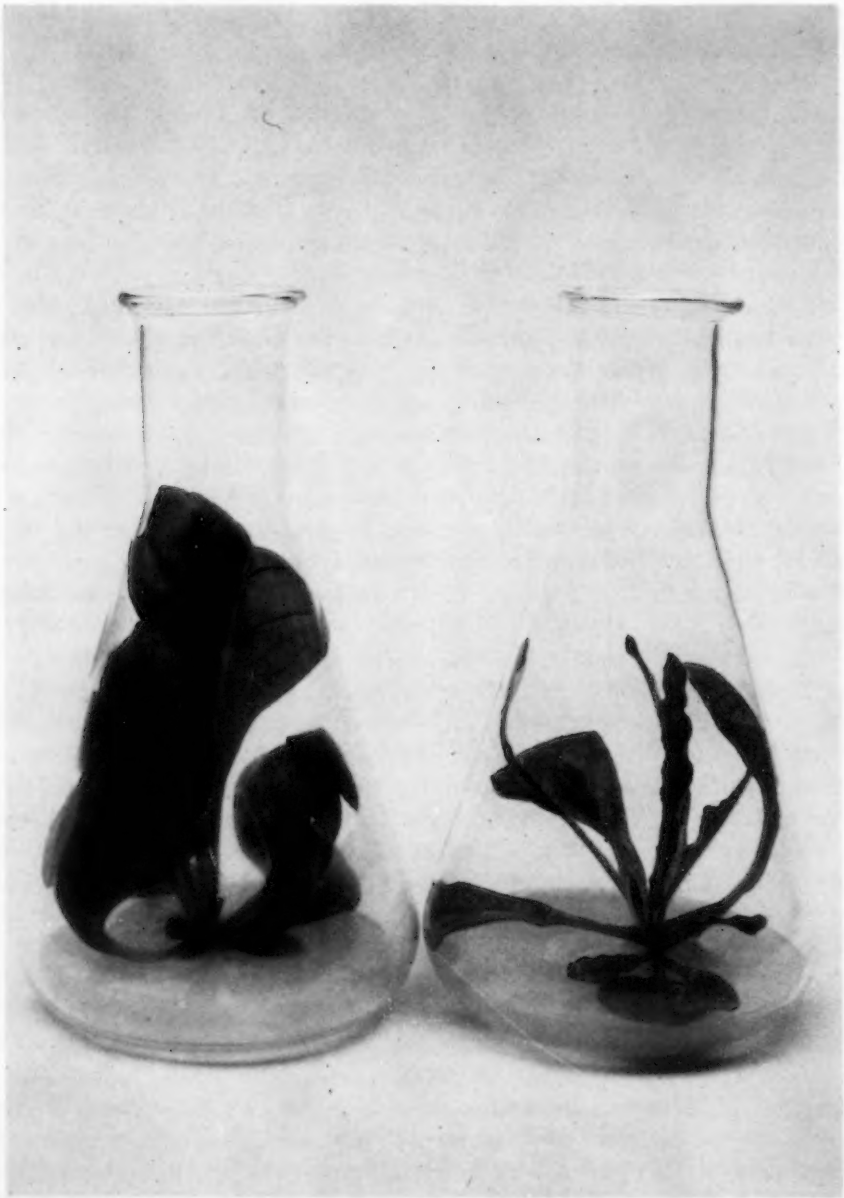

FIG. 1. Maryland Medium Broadleaf tobacco seedlings in aseptic culture. The agar in the flask on the right was inoculated with *Bacillus cereus*.

Figure 2 is another photograph of the same plants after removal from the flasks. It is shown for the purpose of more clearly illustrating the pro-

gressive alterations in color and shape of successively formed leaves. The leaves of the control number 8 and are normal in shape though slightly wilted by heat from the lamps while being photographed. The test plant shows 14 leaves starting with normally shaped leaves at the base and strap-shaped leaves at the apex. An increase in number of leaves is another characteristic of frenching. Much the same progressively developing symptoms of abnormality can be produced with 100 p.p.m. of the natural amino acid, isoleucine, including strap-leaf formation by axillary buds (1947a).

Strain 305 of *B. cereus* was also tested with media containing 200 p.p.m. of neopeptone and bactotryptose, but with poor results. The former caused reticular chlorosis of leaves in 15 days, while the latter gave nega-

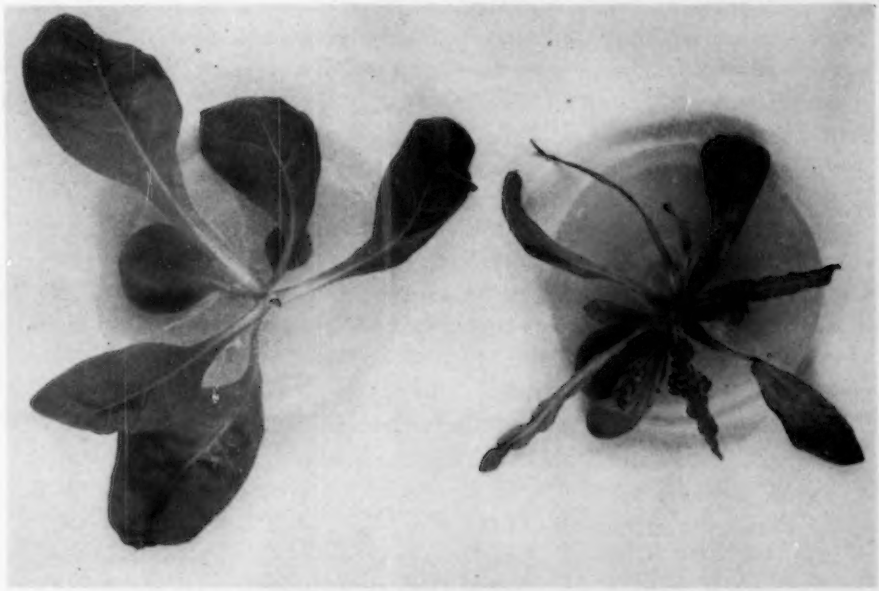

FIG. 2. Top view of the seedling shown in the preceding illustration.

tive results. The use of 200 p.p.m. of bactotryptone also gave excellent results. Reticular chlorosis appeared in 5 days on the third leaf, narrow leaf in 13 days on the fifth leaf, and strap-leaf in 19 days.

Still another comparison of the *B. cereus* strains was made with 200 p.p.m. of bactopeptone and of bactotryptone. This time the nitrogen content of the medium was also varied in five steps from 55 mg. per liter to 227 mg. per liter, exclusive of peptone nitrogen. Reticular chloroses appeared in the leaves of practically all seedlings, but neither caused the formation of strap-shaped leaves on the medium with bactopeptone. Strap leaves appeared, however, with both bacterial strains when bactotryptone was used. This was particularly the case at intermediate nitrogen concen-

trations. Symptoms simulating frenching were most extreme with the 305 strain with 141 mg. per liter of nitrate-nitrogen, but did not appear at a concentration of 227 mg. of nitrate-nitrogen.

Discussion. It would appear from these experiments that an apparently harmless soil bacterium can cause the appearance of symptoms in gross morphology simulating frenching. The ability to do so varies apparently with the bacterial species and strain, the type of organic nitrogen that is available, and the quantity of inorganic nitrogen present. No direct evidence is known for the association of any microorganism with frenching of the tobacco plant in the field. It is known, however, that frenching is quite erratic in its occurrence and that effective soils lose the ability to cause frenching on partial sterilization. *B. cereus* is moreover a very widely distributed soil microorganism and apparently is influenced by presence of organic nitrogen. The progressive development and types of symptoms it produces in aseptic culture parallel those that appear in field plants subject to this abnormality.

The action of increasing quantities of nitrate-nitrogen in aseptic culture of first promoting and then eliminating the symptoms of frenching are also similar to those reported in the greenhouse and field by Valleau and Johnson (1926) and by Shear (1933). Its basis is, in all probability, the need of some nitrogen to permit growth so that symptoms can appear; and the masking or delaying effect of high nitrogen concentrations on appearance of symptoms. The masking action disappears on a sufficient subsequent decrease or of exhaustion of nitrogen.

The desirability of a field study to determine the extent of association between *B. cereus* and frenching of tobacco is self evident. Unfortunately no rapid methods appear to be available for estimating this bacillus in either soil or the rhizosphere of tobacco.

The probable presence of isoleucine in the peptones used to provide nitrogen for these bacteria raises the question whether these results are due primarily to products formed by these microorganisms. Hydrolysis of these peptones may also lead to liberation of free isoleucine. Since it is known that 100 p.p.m. of free natural isoleucine is required to cause extreme symptoms simulating frenching in the Maryland variety of tobacco, this interpretation is improbable. Hydrolysis of 200 p.p.m. of a peptone containing 3 to 5% of isoleucine could result in the liberation of not more than 10 p.p.m. in the medium. This quantity is too small to produce changes in gross morphology with the Maryland variety of tobacco under these experimental conditions.

No free amino acids, including isoleucine, were found in soil on which plants had frenched (unpublished data). On the basis of present informa-

tion therefore it would seem that the primary cause of frenching in tobacco is a hypothetical compound diffusing from one or more apparently non-pathological soil bacteria. This compound has been referred to by Shear (1933) as a toxin, and by the writer (1947a) as a hormonoid (hormone-like) depending on which of the biological properties were considered more important. Its mode of formation and properties would also justify its inclusion among antibiotics. Action of the hypothetical compound on the tobacco plant is considered to produce symptoms as a result of disturbances in the nitrogen metabolism culminating as increases in free isoleucine and other amino acids. It is the presence of these excessive concentrations of free amino acids which is considered to be the immediate cause of the abnormalities in gross morphology that take place. Johnson, West, Jones, and Long (1949) recently announced that *B. cereus* forms an antibiotic. Whether it is identical with the hypothetical compound considered responsible for frenching still has to be determined.

SUMMARY

Tobacco seedlings (Maryland Medium Broadleaf) were grown aseptically in 200 ml. Erlenmeyer flasks on 50 ml. of a complete mineral agar. The temperature was 25° C and illumination about 500 foot candles. *Bacillus cereus* Frankland and Frankland produced symptom patterns in gross morphology of the seedlings that closely approximated those of frenching. Marginal inoculations of the medium were quite effective and demonstrated that roots and bacteria need not be in contact to produce the symptoms. Roots of the seedlings were normal in color, but much shorter and somewhat thicker. The effectiveness of *B. cereus* varied with the strain, the kind and quantity of peptone used, and the concentration of inorganic nitrogen. Bactotryptone, 200 p.p.m., was most effective with 141 p.p.m. of inorganic nitrogen. The presence of 227 p.p.m. of inorganic nitrogen led to masking or delay in appearance of the symptoms. It is suggested that diffusates from *B. cereus* and perhaps other soil bacteria, may be the cause of frenching of tobacco in the field.

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Literature Cited

Johnson, Carles W., West, Harold D., Jones, Hessie L. and Long, Carilyn J. 1949. Biocerin: An antibiotic produced by *Bacillus cereus*. Jour. Bact. **57**: 63–65.

Shear, G. M. 1933. Field and laboratory studies on frenching of tobacco. Va. Agr. Exp. Sta. Technical Bulletin No. **49**.

Steinberg, Robert A. 1947a. Growth responses to organic compounds by tobacco seedlings in aseptic culture. Jour. Agr. Res. **75**: 81–92.

————————. 1947b. Growth responses of tobacco seedlings in aseptic culture to diffusates of some common soil bacteria. Jour. Agr. Res. **75:** 199–206.

Timonin, M. I. 1940. The interaction of higher plants and soil microorganisms. I. Microbial population of rhizosphere of seedlings of certain cultivated plants. Canad. Jour. Res. C. **18:** 307–317.

Valleau, W. D. and Johnson, E. M. 1926. The relation of nitrates to tobacco frenching. Science **64:** 278–279.

Wallace, R. H. and Lochhead, A. G. 1949. Qualitative studies of soil microorganisms: VIII Influence of various crop plants on the nutritional groups of soil bacteria. Soil Science **67:** 63–69.

West, P. M. and Lochhead, A. G. 1940. Qualitative studies of soil microorganisms: IV The rhizosphere in relation to the nutritive requirements of soil bacteria. Canad. Jour. Res. C. **18:** 129–135.

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TORREYA

Interesting New Records and Range Extensions. The common elecampane (*Inula helenium* L.) is, of course, well known in many parts of eastern North America as an early introduction from Europe. The much smaller-headed species, *I. dysenterica* L., *I. salicina* L., and *I. viscosa* Dryand., were collected as waifs in our area many years ago but do not appear to have persisted because there have been no recent reports or collections of them. Another species, *I. brittanica* L., was collected by E. P. Bicknell (*no. 9087*) at Hewlett, Nassau County, N. Y., on September 5, 1915, and is deposited in the local Herbarium at the New York Botanical Garden. The collector notes "a weed in our garden and difficult to eradicate." Recently a sixth species was discovered in our area. First observed in 1948 by Harry Ahles in an unidentifiable condition because of immaturity, it was brought in to my office on September 20, 1949, by another keenly observant local collector and was identified by Mr. J. V. Monachino and Mr. E. J. Alexander as *Inula graveolens* (L.) Desf. Following the general directions given me by the discoverer, I found a large stand of the plant in a new road-fill along Pelham Bay Parkway in the Bronx, Bronx Co., N. Y. (*H. N. Moldenke 20555*). It was also collected in the same locality by Mr. Monachino (*no. 529*) on the same day, September 21st. The plant is apparently thoroughly acclimated here. It has much the habit and general appearance of *Leptilon canadense* (L.) Britton, but the heads are yellow. It varies greatly in size and grows on and along the new road under construction east of the Zoological Park from Pelham Bay Parkway southwards to about 180th Street. Sometimes the individual plants occur scattered far apart, while in other spots they grow in tremendous quantities closely covering an entire area of considerable size. It grows in company with *Diplotaxis tenuifolia* (L.) P. DC. [*Monachino 531, Moldenke 20556*], *Atriplex tatarica* L. [*Monachino 530, Moldenke 20561*], *Lotus corniculatus* L. [*Monachino 535*], and *Verbena officinalis* L. [*Moldenke 20562*]. The soil on which these plants are growing is said to have been ballast brought over here during the past war from southern European ports. The species will probably turn up on ballast elsewhere.

Another interesting recent find is that of *Eupatorium serotinum* Michx., a plant normally found from Delaware southwards. It was discovered by Mr. Monachino in considerable numbers on the new road east of the New York Botanical Garden from Allerton Avenue south to about Thwaites Place [*Monachino 533* and *534*, collected Sept. 3 and 24, 1949, respectively; *Moldenke 20565*]. The species does not seem to have been recorded from the New York City area hitherto. Mr. Monachino also collected the same species (*no. 538*) along the side of the Erie Railroad tracks just outside of Clifton on the way to Paterson, Bergen Co., New Jersey, on October 2, 1949. He reports that there was a good stand of the plant there, although it was not noticed farther on. He also saw the plant in an abandoned lot by the roadside near the corner of Getty Avenue and Harding Avenue, Clifton. The odor of the flowers is sometimes faintly fragrant and pleasant, and at other times musky.

Current manuals list *Veronica scutellata* L. as ranging south only to New York, but I recently collected it in a moist grassy, almost marshy, power-line clearing near Watchung, Somerset Co., N. J. [*Moldenke 20294*]. It was growing in great profusion at this locality.

This summer I collected *Potentilla millegrana* Engelm. as a weed in waste places about tourist cabins at Watkins Glen, Schuyler Co., N. Y. [*Moldenke 20432*]. This western species is not listed in current manuals for New York.—H. N. MOLDENKE.

FIELD TRIP REPORTS

July 3. Martha, N. J. The prolonged drought's affects were very apparent at the Martha bogs this year. The Sphagnum moss stood far out of water in many places—dried and yellowish. There were very few orchids compared with previous years though there was indication that the height of bloom for *Pogonia ophioglossoides* and *Calapogon pulchellus* had passed. Schizea was reduced to a few withered stands. Reversed bladderwort *Utricularia resupinata* which was located in 1948 was not found this year. The large twayblade *Liparis liliifolia* is still present. There were hundreds of blooms of the bog asphodel *Abama americana* and eighty-four plants of the viscid asphodel *Tofieldia racemosa* an increase of about thirty-five over last year. This was the one redeeming factor of an otherwise below par Martha trip. Attendance 15. Leader, David Fables.

July 9. West Orange, N. J. Guests to the fern garden of Mr. W. H. Dole included members of the Fern Society, the New York Enthusiasts and the Torrey Club. The fern specimens especially to be noted were several fine examples of climbing fern *Lygodium palmatum*, the deer fern *Blechnum spicant* with five or six fertile fronds, and the South American deer fern *Blechnum penna marinum*. The ferns were all in good condition due to frequent watering. Over a hundred different species and varieties were seen. Mr. Dole also showed his collection of pressed ferns. Attendance 35. Leader, W. H. Dole.

July 10. Pines Lake, N. J. Rain. No one reported.

July 17–28. No report from the trip to Maritime Alps of France and Italy.

July 24. Allaire, N. J. A fine day. The highlights of the trip were the abundance of green dragon (over twenty specimens), and the small red granular bulbs of the dutchman's breeches. Attendance 5. Leader, Augusta Allen.

August 14. Sim's Place, N. J. We spent some time in Point Pleasant seeing specimens of *Albizzia julibrissin, Gymnocladus dioeca, Sophora japonica* and *Koelreuteria paniculata*. Of course none of these are native but they were interesting as botanical curiosities and as reminders of the days when Point Pleasant sea captains sailed the seven seas. A short distance west of Point Pleasant is a comparatively dry field covered with *Sabatia stellaris*. At Whitebog, Miss White and Miss Vail conducted us through the wonderful gardens of pine barren plants and showed us a fine stand of *Breweria Pickeringii*. Then to Sim's Place where the rare and beautiful *Habenaria integra* was in fine bloom. A pleasing incident was the presence of the directors of the Penn Cranberry Co., owners of Sim's Place, who assured us that the Torrey Club would always be welcome there. Attendance 12. Leader, V. L. Frazee.

August 20. Marine Park, Brooklyn, N. Y. The group started off on this clear cool day at about 10: 30 A.M. from Flatbush Avenue and Avenue U. Part of the park area, that nearest the Marine Parkway Bridge, had unfortunately been recently filled in with sand thus completely obliterating all the vegetation. However, before reaching this section, some interesting plants were observed. Some ripe beach plums, *Prunus maritima*, were noted visually as well as gustatorially. The sand bar willow, *Salix longifolia*, was found in large clumps on the sandy soil. A western plantain, *Plantago arenaria*, was taken special note of. It appears to be of fairly recent advent to this section of the country not even being listed in Gray's Manual, seventh edition; it is however, in Britton and Brown. Only one specimen of ladies' tresses, *Spiranthes cernua*, was located. It appears to have become less abundant here than it previously was. We searched in vain for the pretty little pink and white sabatia, *S. stellaris*, which also had been abundant here. Perhaps it was a bit too early for them.

I understand that the filling in operation was undertaken at the height of the nesting season for the birds of the area. The nests of the birds that build on the ground, like the killdeer, as well as those of the birds that build in the marsh elder, *Iva oraria*, and the bayberry, *Myrica carolinensis*, like the red-winged blackbirds, were either completely destroyed or else abandoned by the frightened parents. Last month, when I chanced to visit this area with the Brooklyn Bird Club, many nests with unhatched eggs or skeletonized young birds in them were pointed out to me. It seems a shame that in planning

such an operation some consideration was not taken of the native wildlife of the area. Timing it a few weeks earlier or later might have saved much of the mass destruction.

After lunch, it was decided to walk across the Marine Parkway Bridge and there ride by bus to another interesting region of salt-marsh sea-side vegetation on Crossbay Boulevard in Queens. There we found, among the tall Phragmites, *P. communis*, a wet area in which Sphagnum moss was growing. A large stand of *Lycopodium adpressum* and some round-leaved sundews, *Drosera rotundifolia*, were here also. Some ferns were observed as well, among them were the marsh fern *Dryopteris Thelypteris*, the royal fern, *Osmunda regalis*, the cinnamon fern, *Osmunda cinnamonea*, and the sensitive fern, *Onoclea sensibilis*. The pretty purple willow herb, *Epilobium hirsutum*, and the salt marsh fleabane, *Pulchea camphorata*, were particularly noted. Two grasses proved to be of interest; they were *Andropogon glomeratus* and *Aristida tuberculosa*. The three Salicornias, *S. mucronata*, *S. europaea*, and *S. ambigua* were among those things found on the mud flats.

All together over eighty species of flowering plants and ferns were noted. Also many interesting shore birds were observed by the group throughout the day. A large flock of black-crowned night herons were an especially rewarding sight. Attendance 10. Leader, Emanuel D. Rudolph.

August 21. Hewitt, N. J. There were virtually no fungi because of the drought, but the expected lichens and hepatics were there. Attendance 10. Leader, G. G. Nearing.

August 22–28. Michigan. This year "Botanical Society of America Excursion" car posters were seen from Ann Arbor, August 20, to the northern peninsula of Michigan where the Third Annual Field Excursion of the Northeastern Section of the Botanical Society of America disbanded August 28. The trip was under the joint sponsorship of the Cranbrook Institute of Science and the University of Michigan. A twenty-one page itinerary with mileage to each stop and lists of notable or characteristic plants and terrain and the names of the leaders, attracted local botanists who were unable to stay throughout the trip. There was an average attendance of 40. Costs were kept low by a planned schedule and the hospitality of college authorities who kept dormitories open after summer school. Michigan was hot but the blankets were eventually used.

The excursion was launched by a reception at the William L. Clements Library (Americana) with an exhibition of rare botanical literature loaned by Mrs. Roy Arthur Hunt of Pittsburg. Several afternoon and evening lectures were given by local authorities.

Some outstanding stops were the Cranbrook Institute of Science, the Hartwick Pines, one of the very few remaining stands of the virgin forest of the Lake Forest type, and the University of Michigan Biological Station at Douglas Lake. After crossing the Straits of Mackinac a stop was made to see the blowouts, forest burial and "graveyard" of the lake shore dunes. Further on dunes arrested by trees and ground cover were observed. A stop was made at Scott's Cave near Munising, one of the two known localities in Michigan for *Schistostega pennata*. On the last delightful day the party roamed the Keweenaw Peninsula.

For special mention: the fine new college buildings in several towns of the state, the Canadian Department of Agriculture car with many full presses on its roof on sunny days, and the very important "red rocket", the "chow wagon" with conspicuous red and silver dome, which could be counted on for gallons of hot coffee and cold water and ample lunches.

The botanical notes in the itinerary are supplemented by Dr. H. T. Darlington's pamphlet, Taxonomic and Ecological Work on the Higher Plants of Michigan, containing an extensive bibliography.

Following close upon the Botanical Society Excursion, the three day foray of the American Bryological Society was held at Birch Island Lodge, Manitoulin, Ontario, between Georgian Bay and Lake Huron. The trip connecting these two botanical expeditions covered a beautiful countryside of balsam fir steeples and arborvitae so luxuriant at the base as to resemble pyramids. For miles the road was through the reservation of the Ojibwa Indians with neat flat-hewn whitewashed log cabins, an occasional school,

Indian orphanage or a baseball game—dignified people apparently unharmed by the sparse tourist travel.

Plant life on Manitoulin is likened to that of the Bruce Peninsula south of it. To the north are the curious Cloche Rocks, uniform bare white hills of the Pre-Cambrian period. A storm prevented a collecting trip here, but in spite of several drenching rains a fine all day launch collecting trip and another by car were made. Attendance 18.

SUPPLEMENT TO LIST OF MEMBERS PUBLISHED JULY 1948

REVISED TO OCT. 21, 1949

COMPILED BY ELVA LAWTON

NEW LIFE MEMBERS

Benedict, Ralph C., 1819 Dorchester Road, Brooklyn 26, N. Y.	1910
Burlingham, Gertrude S., Newfane, Vermont	1910
Dodge, B. O., 3001 Valentine Ave., New York 58, N. Y.	1910
Gier, L. J., William Jewell College, Liberty, Missouri	1949
Hastings, George T., 517 Euclid, Santa Monica, Calif.	1912
Levine, Michael, 100 Halsted Ave., Yonkers 4, N. Y.	1909
Monachino, Joseph, 1417 Grand Concourse, New York 52, N. Y.	1948

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Bessey, Ernst A., 213 University Drive, East Lansing, Mich.
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NEW SUSTAINING MEMBER

McKnight, Kent H., Botany Dept., Brigham Young University, Provo, Utah	1949

NEW ACTIVE MEMBERS

Anthony, Margery S., Division of Natural Sciences, Chico State College, Chico, Calif.	1949
Atchison, Earlene, Dept. of Botany, Univ. of N. Carolina, Chapel Hill, N. Carolina	1949
Bailey, Paul C., Box 14, Montevallo, Alabama	1949
Baker, William H., Dept. of Biol. Sc., Univ. of Idaho, Moscow, Idaho	1948
Ball, Ernest, Dept. of Botany, Univ. of N. Carolina, Raleigh, North Carolina	1949
Bard, Mrs. Gily E., Botany Dept., Rutgers Univ., New Brunswick, New Jersey	1949
Beliz, Jose V. C. Malata, Estacao de M. de Plantas, Elvas, Portugal	1949
Blum, John L., 154 Edna Place, Buffalo, N. Y.	1949
Bolley, Don S., 193 Clinton Ave., Brooklyn 5, N. Y.	1949
Brown, Clarke Q., 103 Aven, Caldwell, Idaho	1949
Burkholder, Paul R., Osborn Botanical Laboratory, Yale Univ., New Haven, Conn.	1948
Camp, Percy, Toms River, New Jersey	1949
Camp, Mrs. Percy, Toms River, New Jersey	1949
Carpenter, John B., Rubber Plant Investigations, Plant Industry Station, Beltsville, Md.	1948
Chan, Allan P., Central Experimental Farm, Ottawa, Canada	1949
Chapman, V. J., Botany Dept., University College, Aukland, New Zealand	1950
Christoff, Alexander, Krasno Selo, Sofia, Bulgaria	1948
Cowan, Richard S., The New York Botanical Garden, New York 58, N. Y.	1949
Cross, Albert W., 420 Ramona St., Palo Alto, Calif.	1949
Dantos, Bento, Inst. Agronomica do Norte, Belem, Para, Brazil, S. A.	1948
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Dickson, James G., Dept. of Plant Pathology, Univ. of Wis., Madison 6, Wisconsin 1949
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Edgar, Ellis C., 1190 S. Country Club Drive, Schenectady 8, New York 1949
Exner, Beatrice B., Francis J. Nicholls Jr. College, Thibodaux, La. 1949
Foster, A. Alfred, Ornamentals Laboratory, Farmingdale, N. Y. 1949
Frohling, Robert C., 1218 Plane St., Union, N. J. 1949
Goidanich, Gabriele, Institute of Plant Pathology, Univ. of Bologna, Bologna, Italy 1950
Golub, Samuel J., 47 Federal St., Springfield, Mass. 1949
Gregory, Luis E., U. S. D. A. Rubber Field Station, Box 68, Turrialba, Costa Rica 1949
Hall, Benedict A., State Teachers College, Cortland, N. Y. 1949
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Hesseltine, C. W., Dept. 910, Bldg. 100, Lederle Laboratories, Inc., Pearl River, N. Y. 1949
Holbert, J. R., Funk Bros. Seed Co., Bloomington, Ill. 1949
Holtzman, Mrs. Doris, Long Island Univ., Brooklyn, N. Y. 1949
Howe, Thomas D., Defiance College, Defiance, Ohio 1949
Hume, H. Harold, College of Agriculture, Gainesville, Fla. 1936
Hutner, S. H., Haskins Laboratory, 305 East 43rd St., New York 17, N. Y. 1949
Inge, Frederick D., Hampton Institute, Hampton, Va. 1948
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Kurtz, Edwin B. Jr., 1055 San Pasqual, Pasadena 5, Calif. 1949
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Lane, Irwin E., Botany Dept., Univ. of Hawaii, Honolulu 14, Hawaii 1949
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Larsen, Victor R., Barnard College, Columbia Univ., New York 27, New York 1947
Lawrence, George H. M., Bailey Hortorium, Sage Place, Ithaca, N. Y. 1948
Levesque, Bro. Lucien, C.S.C. Serv. de Bib., Univ. of Montreal, 2900 Blvd. Mont Royal, Montreal 26, Canada 1949
Loeffler, Robert J., 83 New Bond St., Worcester 6, Mass. 1949
McClintock, Barbara, Carnegie Inst., Cold Spring Harbor, Long Island, N. Y. 1949
McIlvaine, Harold, Botany Dept., Univ. of Idaho, Moscow, Idaho 1949
Maheshwari, P., Botany Dept., Univ. of Delhi, Delhi, India 1950
Marengo, Norman P., 114 West 183rd St., New York 53, N. Y. 1949
Maramorosch, Karl, Rockefeller Inst. for Medical Research, 66th and York Ave., New York 21, N. Y. 1949
Menadier, Mrs. Mabel V., 574 Bergen Ave., Jersey City 4, N. J. 1949
Menzel, Margaret Y., Box 4756, College Station, Texas 1949
Mes, Margaretha G., Dept. of Botany, Univ. of Pretoria, Pretoria, South Africa 1949
Mullahy, John H., 2001 West End Ave., Nashville, Tenn. 1949
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Orellana, Rodrigo G., 2532 N. 17th, Kansas City, Kansas 1949
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Pangburn, Mildred, Centenary Junior College, Hackettstown, N. J. 1948
Peklo, Jaraslov, Prague XII, Chodska 3 II 1948
Phillips, Elsie P., The New York Botanical Garden, New York 58, New York 1949

Phinney, Harry K., Dept. of Botany, Oregon State College, Corvallis, Oregon 1949
Platt, Robert B., Dept. of Biology, Emory Univ., Georgia 1949
Politis, John Ch., Botany Dept., Univ. of Athens, 104 Solonos Street, Athens, Greece 1950
Popham, Richard A., Dept. of Botany, Ohio State Univ., Columbus 10, Ohio 1949
Popp, H. W., 417 East Adams Ave., State College, Pa. 1949
Porter, C. L., Rocky Mt. Herbarium, Eng. Bldg., Univ. of Wyoming, Laramie, Wyoming 1949
Price, W. C., Plant Virus Laboratory, Phipps Conservatory, Pittsburgh 13, Pa. 1949
af Rantzien, Henning Horn, Naturhistorska Riksmuseet, Stockholm 50, Sweden 1949
Razi, B .A., Central College, Bangalore, India 1949
Reynolds, Howard C., The New York Botanical Garden, New York 58, New York 1949
Ritchie, Donald D., Botany Dept., Barnard College, New York 27, New York 1949
Rousseau, Jacques, Botanical Garden, 4101 Sherbrooke St., East, Montreal, Quebec, Canada 1948
Savulescu, Traian, Inst. de Cercetari Agr. al Romaniei, Bulevardui Marasti nr. 61, Bucharest, Rumania 1938
Shively, S. B., Nebraska Wesleyan Univ., Lincoln 4, Nebraska 1949
Silberschmidt, Karl, Inst. Biologico, C. P. 119 A. Sao Paulo, Brazil, S. A. 1948
Svedelius, Nils E., Kyrkogardsg 5a, Upsala, Sweden 1949
Terrell, Edward E., 616 N. South St., Wilmington, Ohio 1949
Wang, F. H., Inst. of Botany, Acad. Sinica., 320 Yoyang Rd., Shanghai 18, China 1950
Weaver, Harry L., Dept. of Botany, Univ. of Nebraska, Lincoln 8, Nebraska 1949
White, Stephen S., American Embassy, Quito, Ecuador, S. A. 1949
White, Sylvia, Botany Dept., U. S. National Museum, Washington 25, D. C. 1949
Wilcox, Hugh, Oregon Forest Products Laboratory, 17th and May Sts., Corvallis, Oregon 1949
Wood, John L., 43 Phillips St., Greenfield, Mass. 1949
Wurdack, John J., The New York Botanical Garden, New York 58, N. Y. 1949
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Belson, Dr. Maurice A., 318 East 187th St., New York 57, N. Y.	1950
Berleant, Ida, 419 West 119th St., Apt. 2F, New York 27, N. Y.	1948
Beyer, Ruth A., 1432 North 60th St., Philadelphia 31, Pa.	1948
Boyle, E. Marie, The Baldwin School, Bryn Mawr, Pa.	1949
Brodix, C. Raymond, 331 East 47th St., New York 17, N. Y.	1948

Clark, Harold E., Dept. of Plant Physiology, New Jersey Agri. Exp. Station, New Brunswick, N. J. 1949
Cohn, Mark, 2827 Valentine Ave., New York 58, N. Y. 1949
deHondt, Barbara B., 33-12 213th St., Bayside, N. Y. 1948
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Fables, David, 421 Walnut St., Roselle Park, N. J. 1947
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Gallaher, Marguerite, Victoria Foundation, Morris Plains, New Jersey 1950
Gonshorel, Mary F., 1273 East 93rd St., Brooklyn 12, N. Y. 1948
Goodman, Ruth, 1975 Creston Ave., New York 53, N. Y. 1949
Harrington, Mrs. Marshall C., Dellwood Park, Madison, N. J. 1948
Heineman, Bernard, Bristol Laboratories, Syracuse, N. Y. 1949
Ilnicki, Richard D., Jamesburg, N. J. 1949
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Mealy, Marie A., 203 Second Ave., Lyndalia 89, Delaware 1946
Messing, Simon D., 68 Cabrini Blvd., New York 33, N. Y. 1948
Meyer, Jane, 61 Fanshaw Ave., Yonkers, N. Y. 1949
Miller, Mrs. C. A., 28 Oakland Place, Summit, N. J. 1948
Murray, Gordon N., Dept. of Biology, Univ. of Tenn. Jr. College, Martin, Tenn. 1949
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Prat, Henri, Director Inst. of Biology, Univ. of Montreal, 2900 Blvd., Mont Royal, Montreal, Canada 1949
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Ralston, Janet H., 45 N. 18th St., East Orange, N. J. 1949
Sangree, John B., Glassboro, N. J. 1949
Schwartz, Helen J., 238 Madison Ave., New York 16, N. Y. 1948
Seaman, Anne O., 2755 Briggs Ave., New York 58, N. Y. 1949
Sparrow, A. H., Brookhaven National Laboratory, Upton, L. I., New York 1949
Stein, Sylvia, 2728 Wallace Ave., New York 67, N. Y. 1948
Van Iterson, Prof., Jr. Baarn, Netherlands 1949
Weigele, Clara, 417 Sanhican Drive, Trenton, N. J. 1949
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Botany of the Canadian Eastern Arctic, Part III, Vegetation and Ecology. By Nicholas Polunin. vii + 304 pages; *pl. 1–107; fig. 1; map in pocket.* National Museum of Canada Bull. 104, Biol. Series No. 32, Ottawa. 1948. 75¢.

"The *flora* of an area is the sum total of different 'kinds' of plants inhabiting it, no matter whether they are scarce or plentiful. The *vegetation*, on the other hand, is concerned largely with the question of relative abundance, being the total 'display' that the plants make collectively. Their *ecology* is their relationship to environment . . . ." In these words Dr. Polunin clarifies the subject of this volume on the vegetation and ecology of the Arctic as distinguished from parts I and II which deal primarily with the flora.

"The climax proper, or lasting preclimax . . . , is probably the less heathy and more grassy-sedgy community to be seen on flat areas away from the exposed coast . . . although this must remain somewhat doubtful pending further investigation . . . it is to my mind doubtful whether the principles of the climatic climax, which are so useful especially in temperate regions, are really applicable in the Arctic . . . ." Referring to a possible regional climax, he describes areas affected by a concentration of waterfowl: "These must considerably increase the available nitrogenous and other food materials and probably contribute appreciably to the luxuriance of the vegetation, which may perhaps be here again fast approaching the 'true climax' (whatever that may be, and supposing such to be recognizable!)." These comments on climax refer specifically to the region about Dundas Harbour, Devon Island. With reservation in part explainable by the above quotations the author does attempt to assign the term "climax" to a community in most of the other localities in which he worked in the region.

Reading this work, one feels that the difficulty in recognizing a climatic climax in this region may in large part be the result of the very youthfulness of the area. One is constantly reminded of both the recent deglaciation and emergence of large areas from the sea. Referring for instance to the land about Clyde "River", Dr. Polunin indicates that it has been left " . . . open to colonization by plants only in relatively recent times (perhaps only a few hundred years ago, or less in some instances), owing either to recent ice recession or to recent uplift."

This youthfulness is reflected in the soils. There appears to be no profile development beyond the sometimes slight accumulation of humus in the upper level. Peat accumulation of more than a few inches at most seems not to have occurred. Concerning marshes near Chesterfield where *Sphagnum* is much in evidence, Dr. Polunin writes: "Even here there is rarely if ever a humous deposit of any real depth; when the feet sink into a 'squishy' lakeside swamp they generally meet a hard rock or stony substratum not far down." The marked effect of manuring in this region emphasizes the restrictive effects of lack of weathering. The pH was high compared to temperate regions in general. Lower pH was found in the more southern parts of the range as for example in northern Labrador where the author mentions a pH of 5.6 which appears to be low for the region. That the poverty of the vegetation in the Arctic may be due more to edaphic than to climatic factors is suggested by the response of vegetation to local fertilization by birds around localities that they frequent in considerable numbers.

Of interest to one familiar with the vegetation in limestone areas of temperate regions is the barrenness of such areas in the Arctic Dr. Polunin refers to the more highly vegetated dark soils and rocks compared with the poverty of the light colored substrata. No attempt is made at explanation of the difference and one wonders if it is a function of the mineral supply, the moisture retention, or the microclimatic phenomena resulting from the difference in the albedo of the two.

On the west coast of Hudson Bay Dr. Polunin " . . . got the impression that algal pioneers were introducing ameliorating factors which favored colonization by, and ultimate luxuriance of, higher plants as in other parts of the world . . . ." Elsewhere as well plant succession is mentioned but this, as well as more emphasis on the climax

and other ecological problems which might have been included here, is promised in a book to be published by the Chronica Botanica Company.

The volume is a paper-bound book consisting of 304 pages. It is illustrated with one figure which is a map showing ten subdivisions of the region, with one hundred and seven photographs illustrating vegetation types, and with a large map of the region in the pocket at the back. It includes an index to place names and one to Latin names. The bibliography includes a total of one hundred and ninety-four entries of which forty-seven are Dr. Polunin's own publications indicating his great activity in arctic studies.

The text takes up each subdivision of the Canadian Eastern Arctic in a sequence from north to south and east to west. Geographical limits, topography, geology and climate are briefly reviewed for each. Whatever the author could glean from the literature is then presented. Previous to Dr. Polunin's work suprisingly little attention had been given to the vegetation and ecology of the Arctic. The review of earlier contributions is followed by accounts of his own studies wherever he had been able to work. He has included in addition to angiosperms, the pteridophytes, bryophytes, algae, and fungi. No gymnosperms are mentioned as occurring in the district—an interesting fact in view of the geographic limits of the region. Reference to the floristic part of the series indicates that none has been found.

This volume represents a very useful starting point for future arctic studies. With our increasing interest in the Arctic and our greatly improved access to the region, such studies are bound to increase. Since this work gathers together both the meager gleanings from other workers and Dr. Polunin's own studies, the volume must certainly prove to be of great value for anyone starting ecological research in the Arctic. That it represents only a mere start is very clear when one realizes that Dr. Polunin's own careful observations were primarily made within a five mile radius or less of the Hudson Bay Company posts or other points of call scattered thinly through a region of nearly half a million square miles. It includes most of the land east of the ninety fifth meridian and north of the sixtieth parallel. Thus it extends through a range of twenty-three degrees of latitude (as if from Key West to northern Maine!).—Murray F. Buell.

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INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITOR OF THE TAXONOMIC INDEX

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

Chute, R. M. *Basicladia* in Maine. Rhodora **51**: 232. S [4 O] 1949.

Dawson, E. Yale. Contributions toward a marine flora of the southern California Channel Islands. I–III. Allan Hancock Found. Publ. Occ. Pap. **8**: 1–57. *f. 1–58.* Au 1948.

Dawson, E. Yale. Resultados preliminares du un reconocimento de las algas marinas de la costa pacifica de México. Revista Soc. Mex. Hist. Nat. **9**: 215–254. *1 map.* S 1949.

Lindauer, Victor W. Notes on marine algae of New Zealand. Pacif. Sci. **3**: 340–352. *f. 1–8.* O 1949.

Nielsen, C. S. & Madsen, Grace C. Check list of the algae of northern Florida. I. Quart. Jour. Fla. Acad. **11**: 63–68. Je-S 1948 [O 1949].

Woodhead, N. & Tweed, R. D. Some algal floras of high altitudes in Snowdonia. Northw. Nat. **22**: 34–42. *f. 1–4.* 1947.

FUNGI AND LICHENS

(See also under Phytopathology: **Baker, K. F. et al.**)

Dix, W. L. Supplementary notes on the *Cladoniae* of Pennsylvania. Bartonia **25**: 74–85. *pl. 2, 3.* 12 O 1949.

Gray, William D. The laboratory cultivation and development of the Myxomycetes *Physarella oblonga* and *Physarum didermoides.* Ohio Jour. Sci. **49**: 105–108. *f. 1–11.* My [Je] 1949.

Johnson, E. M. & Valleau, W. D. Synonymy in some species of *Cercospora.* Phytopathology **39**: 763–770. *table 1.* O 1949.

Karling, John S. Three new species of *Chytriomyces* from Maryland. Bull. Torrey Club **76**: 352–363. *f. 1–52.* S–O [Au] 1949.

Lindquist, Juan C. Una nueva especie de *Uromyces* parasito, para la flora argentina. Notas Mus. La Plata Bot. **14**^{er}: 51–54. *1 f.* 27 My 1949.

Mundkur, Balaji D. Evidence excluding mutations, polysomy, and polyploidy as possible causes of non-Mendelian segregations in *Saccharomyces.* Ann. Mo. Bot. Gard. **36**: 259–279. *pl. 1+f. 1. tables 1–10.* S 1949.

Thirumalachar, M. J. Critical notes on some plant rusts. Bull. Torrey Club **76**: 339–342. *f. 1–4* S–O [Au] 1949.

PTERIDOPHYTES

Copeland, Edwin B. Further notes on the ferns of Fiji. Jour. Arnold Arb. **30**: 433–442. 15 O 1949.

Shaver, J. M. A study of Tennessee ferns belonging to the genera *Phegopteris, Polystichum* and *Cystopteris.* Jour. Tenn. Acad. **24**: 179–194. Jl 1949.

SPERMATOPHYTES

Allard, H. A. An analysis of seeding progeny of *Quercus*. Castanea **14**: 109–117. S 1949.

Baker, Milo S. Studies in western violets—V. Leafl. West Bot. **5**: 173–117. 23 Au 1949.

Baldwin, J. T. *Helenium Curtisii* in Virginia. Rhodora **51**: 303, 304. O 1949.

Baldwin, J. T. Hybrid of *Kalanchoë daigremontiana* and *K. verticillata*. Bull. Torrey Club **76**: 343–345. *f. 1–4*. S–O [Au] 1949.

Baldwin, J. T. & Speese, Bernice M. Cytogeography of *Emilia* in West Africa. Bull. Torrey Club **76**: 346–351. *f. 1–14*. S–O [Au] 1949.

Barkley, F. A. Clave descriptiva de los orderes de los Anthophyta. Revista Fac. Agron. [Medellin] **9**: 27–69. 1949.

Barkley, F. A Lista de los órdenes y familias de los Anthophyta con ejempelares genéricos seleccionados. Revista Fac. Agron. [Medellin] **8**: 153–368. 1948.

Barkley, F. A. Mapa filogenética de las Anthophyta. Revista Fac. Agron. [Medellin] **8**: 369–373. 1948.

Barkley, F. A. Nota taxonómica. Revista Fac. Agron. [Medellin] **8**: 151, 152. 1948.

Barkley, F. A. & Gabriel Gutiérrez, V. Colectores de plantes en Columbia tal como están representados en los herbarios del pais. Revista Fac. Agron. [Medellin] **8**: 85–107. 1948.

Boelcke, O. Una variedad de *Sinapis arvensis* adventicia en Balcarce. Revista Argent. Agron. **16**: 168–172. *f. 1*. S 1949.

Burkart, Arturo. Contribución al estudio del género *Adesmia* (Leguminosae). Lilloa **15**: 1–17. *pl. 1, 2 + f. 1–5*. 30 D 1948.

Burkart, Arturo. Nota sobre el género *Clitoria* (Phaseoleae) en la Argentina. Darwiniana **8**: 488–495. *pl. 1 + f. 1, 2*. 25 Jl 1949.

Burkart, Arturo. Notas sobre algunas plantas exóticas adventicias o naturalizadas en la Republica Argentina. Lilloa **15**: 19–26. *pl. 1, 2*. 30 D 1948.

Cabrera, Angel L. El género *Senecio* en Chile. Lilloa **15**: 27–501. *f. 1–176*. 30 D 1948.

Cheesman, E. E. Classification of the bananas. III. Critical notes on the species. Kew Bull. **1949**: 133–137. *pl. 1, 2*. 1949. 265–272. *pl. 1, 2*.

Clausen, Robert T. Checklist of the vascular plants of the Cayuga quadrangle 42°–43° N., 76°–77° W. Mem. Cornell Exp. Sta. **291**: 5–87. S 1949.

Covas, Guillermo. Observaciones sobre la sistemática del género *Hordeum*. Revista Argent. Agron. **16**: 173–177. *f. 1*. S 1949.

Cronquist, Arthur. Noteworthy plants of Georgia. Castanea **14**: 101–108. S 1949.

Duman, Maximilian G. Range extensions of *Carex neurochlaena* Holm. Bull. Torrey Club **76**: 337, 338. S–O [Au] 1949.

Duncan, Wilbur H. & Jones, Thomas J. Poisonous plants of Georgia. Bull. Univ. Ga. School Vet. Med. **49**[12]: *i–ix*, 1–46. *f. 1–24 + maps 1–13*. Ap 1949.

Engelbeen, M. Contribution expérimentelle à l'étude de la biologie florale de *Cinchona Ledgeriana* Moens. Publ. Inst. Étude Agron. Congo. Belg. Ser. Sci. **40**: 1–135. 1949.

Eyerdam, Walter J. Largest *Lysichitum* leaf. Leafl. West. Bot. **5**: 186. 23 Au 1948.

Fernald, M. L. Errors in citation of *Agrostis* and *Convolvulus*. Rhodora **51**: 192, 193. S [4 O] 1949.

Fosberg, F. R. A new *Drymaria* (Caryophyllaceae) from Mexico. Proc. Biol. Soc. Wash. **62**: 147, 148. 23 Au 1949.

Fox, Henry. On the occurrence of *Franklinia* in Cape May County, New Jersey. Bartonia **25**: 69. 12 O 1949.

Gentry, Howard Scott. Land plants collected by the Allan Hancock Atlant. Expedition of 1939. Allan Hancock Atlantic Exp. Rep. **6**: 1–46. *pl. 1, 2.* 30 Je 1948.

Gentry, Howard Scott. Land plants collected by the Velero III, Allan Hancock Pacific Expeditions 1937–1941. Allan Hancock Pacif. Exp. **13²**: 1–245. *pl. 1–15 + maps 1–3.* 23 Jl 1949.

Grondona, Eduardo M. *Monrosia.* nuevo género de Poligaláceas. Darwiniana **8**: 411–414. *f. 1.* 25 Jl 1949.

Hara, Hiroshi. A note on *Chrysosplenium iowense.* Rhodora **51**: 191, 192. S [4 O] 1949.

Hermann, F. J. A new *Juncus* from California and Oregon. Leafl. West. Bot. **5**: 182, 183. 23 Au 1949.

Hermann, Frederick J. New species of *Lonchocarpus* from Panama. Ann. Mo. Bot. Gard. **36**: 281–284. S 1949.

Hermann, Frederick J. Studies in *Lonchocarpus* and related genera, V: New species from middle America and the *Lonchocarpus guatemalensis* complex. Jour. Wash. Acad. **39**: 306–313. 15 S 1949.

Hoover, Robert F. Notes on *Monardella.* Leafl. West. Bot. **5**: 179–182. 23 Au 1949.

Howard, Richard A. The genus *Coccoloba* in Cuba. Jour. Arnold Arb. **30**: 388–424. 15 O 1949.

Howell, John Thomas. Another lettuce in Oregon. Leafl. West. Bot. **5**: 186. 23 Au 1949.

Howell, John Thomas. Arctic hairgrass in the Sierra Nevada. Leafl. West. Bot. **5**: 187. 23 Au 1949.

Howell, John Thomas. California records for Russian olive. Leafl. West. Bot. **5**: 188. 23 Au 1949.

Howell, John Thomas. Further California records of *Brachypodium.* Leafl. West. Bot. **5**: 188. 23 Au 1949.

Howell, John Thomas. *Medicago minima* in California and Arizona. Leafl. West. Bot. **5**: 187. 23 Au 1949.

Howell, John Thomas. *Ornithopus roseus* in California. Leafl. West. Bot. **5**: 186. 23 Au 1949.

Howell, J. T. Plant types in the herbarium of the California Academy of Sciences. II. Wasmann Collect. **7**: 220–230. Ap 1949.

Howell, John Thomas. The rediscovery of *Antirrhinum ovatum.* Leafl. West. Bot. **5**: 184, 185. 23 Au 1949.

Isfort, Louise G. A partial bibliography of natural history in the Chicago region [botany p. 432–442]. Am. Midl. Nat. **42**: 406–472. S 1949.

Krukoff, B. A. & Monachino, J. The genus *Strychnos* in Surinam. Darwiniana **8**: 476–480. 25 Jl 1949.

Manning, Wayne E. The genus *Carya* in Mexico. Jour. Arnold Arb. **30**: 425–432. 15 O 1949.

Martin, Raimundo R. Consideraciones generales sobre la flora actual de las turberas de Tierra del Fuego. Revista Argent. Agron. **16**: 149–155. *f. 1–5.* S 1949.

Martinez Crovetto, Raul. Las especies argentinas del género *Melothria* (Cucurbitaceae). Darwiniana **8**: 496–518. *f. 1–7.* 25 Jl 1949.

Menzies, Robert H. Size and age data for *Arbutus Menziesii* in Marin County, California. Leafl. West. Bot. **5**: 188. 23 Au 1949.

Merrill, E. D. & Hu, Shiu-Ying. Work and publications of Henry Muhlenberg, with special attention to unrecorded or incorrectly recorded binomials. Bartonia **25**: 1–66. *1 pl.* 12 O 1949.

Moldenke, H. N. The known geographic distribution of the members of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae. 1–215 [processed]. New York, the author. 1949.

Morton, C. V. A new *Brunfelsia* from Brazil. Proc. Biol. Soc. Wash. **62**: 151, 152. 23 Au 1949.

Munz, Philip A. A new Columbine from Colorado. Leafl. West. Bot. **5**: 177, 179. 23 Au 1949.

Nielsen, Sarah Dyal. Systematic studies in the Valerianaceae. Am. Midl. Nat. **42**: 480–499. *f. 1–27.* S 1949.

Parodi, Lorenzo R. Las gramíneas sud-americanas del género *Deschampsia.* Darwiniana **8**: 415–475. *f. 1–21.* 25 Jl 1949.

Rosendahl, C. O. & Cronquist, Arthur. The asters of Minnesota: a floristic study. Am. Midl. Nat. **32**: 502–512. S 1949.

Sandwith, N. Y. Contributions to the flora of tropical America XLIX. Notes on Rubiaceae. Kew Bull. **1949**: 253–264. 1949.

Schery, Robert W. A first record for the genus *Qualea* (Vochysiceae) from North America (Panama). Ann. Mo. Bot. Gard. **36**: 285, 286. S 1949.

Schultes, Richard Evans. Plantae Colombianae XII. De plantis principaliter amazoniae colombianae investigationes. Bot. Mus. Leafl. **14**: 21–47. *pl. 7–11.* 26 O 1949.

Senior, Robert M. *Campanula Rentonae*, sp. nov. Rhodora **51**: 302, 303. O 1949.

Stonor, C. R. & Anderson, Edgar. Maize among the hill peoples of Assam. Ann. Mo. Bot. Gard. **36**: 355–404. *pl. 18–22 + f. 1, 2.* S 1949.

Troncoso, Nelida S. Notas sobre dos verbenas patagónicas. Darwiniana **8**: 481–487. *f. 1–3.* 25 Jl 1949.

Venard, Haskell. The white form of *Aster puniceus*, var. *firmus.* Rhodora **51**: 231, 232. S [4 O] 1949.

Walker, Egbert H. & Rodin, Robert. Additional phanerogams in the flora of Guam, with notes on unverified records. Contr. U. S. Nat. Herb. **30**: 449–468. *pl. 8, 9.* 1949.

Wherry, Edgar T. Further observations on eastern Tiarellas. Bartonia **25**: 70. 12 O 1949.

Wherry, Edgar T. Postscript on eastern lilies. Bartonia **25**: 71, 72. 12 O 1949.

Wherry, Edgar T. *Trillium pusillum* in Maryland. Bartonia **25**: 71. 12 O 1949.

Wikoff, Stanley D. *Lemna trisulca*, a southward extension of range on the Atlantic coastal plain. Bartonia **25**: 72, 73. 12 O 1949.

Yuncker, T. G. Additional notes on the Fijian species of *Peperomia.* Jour. Arnold Arb. **30**: 443–449. 15 O 1949.

ECOLOGY AND PLANT GEOGRAPHY

Albertson, F. W. Man's disorder of Nature's design in the Great Plains; a presidential address. Trans. Kan. Acad. **52**: 117–131. *f. 1–8.* 1949.

Deevy, Edward S. Biogeography of the Pleistocene. Bull. Geol. Soc. Am. **60**: 1315–1416. *f. 1–27. + tables 1–6.* S 1949.

Dickinson, J. C. An ecological reconnaissance of the biota of some ponds and ditches in northern Florida. Quart. Jour. Fla. Acad. **11**: 1–28. Je–S 1948 [O 1949].

Eshbaugh, Fred P. The place of research in relation to certain phases of stripland reclamation in Kansas. Trans Kan. Acad. **52**: 149–159. *f. 1–23.* 1949.

Evenari, Michael. Ecologia de las plantas de desierto. Revista Argent. Agron. **16**: 121–148. *f. 1–11 + tables 1–7.* S 1949.

PALEOBOTANY

(See also under Pteridophytes: **Baxter, R. W.**; under Ecology: **Deevy, E. S.**)

Baxter, Robert W. Some Pteridosperm stems and fructifications with particular reference to the medullosae. Ann. Mo. Bot. Gard. **36**: 287–352. *pl. 2–17 + f. 1–4.* S 1949.

Chaney, Ralph W. Early tertiary ecotones in western North America. Proc. Nat. Acad. **35**: 356–359. 15 Je 1949.

Hansen, Henry P. Pollen content of moss polsters in relation to forest composition. Am. Midl. Nat. **42**: 473–479. *tables 1–3.* S. 1949.

PHYTOPATHOLOGY

Baker, Kenneth F., Dimock, A. W. & Davis, Lily H. Life history and control of the *Ascochyta* ray blight of *Chrysanthemum.* Phytopathology **39**: 789–805. *f. 1–3.* O 1949.

Calvert, O. H. & Pound, Glenn. Stimulated pycnidium production and symphogenous pycnidia in *Phoma lingam.* Phytopathology **39**: 848–857. *f. 1 tables 1–3.* O 1949.

Campbell, W. A. Relative abundance of *Phytophthora cinnamomi* in the root zones of healthy and littleleaf–diseased shortleaf pine. Phytopathology **39**: 752, 753. S 1949.

Chen, S. T. Sporulation of *Gibberella zeae* on rice straw. Phytopathology **39**: 761, 762. S 1949.

Ciccarone, Antonio. Zonate leaf spot of sorghum in Venezuela. Phytopathology **39**: 760, 761. S 1949.

Dunlap, A. A. & Harrison, A. L. Dying of live oaks in Texas. Phytopathology **39**: 715–717. *f. 1.* S 1949.

Gregory, P. H. *et. al.* Death of Sycamore trees [*Acer pseudoplatanus*] associated with an unidentified fungus. Nature **164**: 275. 13 Au 1949.

Hagedorn, D. J. & Walker, J. C. Wisconsin pea streak. Phytopathology **39**: 837–847. *f. 1–3 + tables 1–3.* O 1949.

Jackowska, Sophie. Effects of *Bacterium tumefaciens* on *Allium cepa.* Phytopathology **39**: 683–705. *f. 1–15.* S 1949.

Large, John R. Rough bark of tung, a virus disease. Phytopathology **39**: 718–720. *f. 1 + table 1.* S 1949.

Locke, Seth Barton. Resistance to early blight and *Septoria* leaf spot in the genus *Lycopersicon.* Phytopathology **39**: 829–836. *table 1.* O 1949.

McKinney, H. H. & Fulton, Robert W. Local susceptibility of cotyledons and leaves of cucumber to tobacco mosaic virus. Phytopathology **39**: 806–812. *f. 1 + tables 1, 2.* O 1949.

Middleton, John T., Stone, M. W., & Kendrick, J. B. Incidence of Lima bean root rot in soils treated with fumigants and insecticides for control of wire worms. Phytopathology **39**: 813–821. *table 1.* O 1949.

Mundkur, Balaji D. Morphology and cytology of development of the sex organs of *Phytophthora himalayensis* Dastur. Bot. Gaz. **110:** 475–486. *f. 1–27.* Mr. [9 Je] 1949.

Thirmulachar, M. J., Whitehead, Marvin D., & Boyle, John S. Gametogenesis and oospore formation in *Cystopus (Albugo) evolvuli.* Bot. Gaz. **110:** 487–491. *f. 1–16.* Mr [9 Je] 1949.

Toole, E. Richard. Fusarium wilt of staghorn sumac. Phytopathology **39:** 754–759. *f. 1, 2+table 1.* S 1949.

Vlitos, A. J. & Preston, D. A. Seed treatment of field legumes. Phytopathology **39:** 706–714. *tables 1–5.* S 1949.

Wells, D. G., Hare, W. W. & Walker, J. C. Evaluation of resistance and susceptibility in garden peas to near-wilt in the greenhouse. Phytopathology **39:** 771–779. *f. 1, 2+table 1.* O 1949.

Yarwood, C. E. Effect of soil moisture and mineral nutrient concentration on the development of bean powdery mildew. Phytopathology **39:** 780–788. *table 1.* O 1949.

Zentmyer, George A. Verticillium wilt of avocado. Phytopathology **39:** 677–682. *f. 1–3* S 1949.

MORPHOLOGY

(including anatomy and cytology in part)

Ashby, E. & Wangermann, E. Senescence and rejuvenation in *Lemna minor.* Nature **164:** 187. 31 Jl 1949.

Ashby, Eric. Studies in the morphogenesis of leaves. I. An essay in the leaf shape. New Phytol. **47:** 153–176. *1. 1–13.*. 1948. II. The area, cell size and cell number of leaves of *Ipomoea,* in relation to their position on the shoot. 177–195. *f. 1–13.*

Caceres, Manual R. Ramificación del tubo polínico en *Vitis vinifera.* Revista Argent. Agron. **16:** 178, 179. *f. 1.* S 1949.

Wardlaw, C. W. Phyllotaxis and organogenesis in ferns. Nature **164:** 167–169. *f. 1–6.* 30 Jl 1949.

Wardrop, A. B. Micellar organization in primary cell walls. Nature **164:** 366. *f. 1–2.* 27 Au 1949.

GENETICS

(including cytogenetics)
(see also under Spermatophytes: **Baldwin**)

Bailey, Paul C. Differential chromosome segments in *Trillium erectum* L. Bull. Torrey Club **76:** 319–336. *f. 1–11+tables 1, 2.* S–O [Au] 1949.

Burnham, C. R. Chromosome segregation in maize translocations in relation to crossing over in interstitial segments. Proc. Nat. Acad. **35:** 349–356. *f. 1.* Jl. 1949.

Burgos, Julio C. & Caceres, Manuel R. Noticia complementaria acerca de la propagación vegetativa del viraró (*Pterogyne nitens* Tul.) por trozos de raiz. Darwiniana **8:** 519, 520. *f. 1.* 25 Jl 1949.

Cook, Robert C. Lysenko's Marxist genetics, Science or religion? Jour. Hered. **40:** 169–202. *f. 1–7.* Jl 1949.

Dermen, Haig. Are the pomes amphidiploids? A note on the possible origin of Pomoideae. Jour. Hered. **40:** 220, 221. Au 1949.

Leikind, Morris C. The genetics controversy in the USSR; a bibliographic survey. Jour. Hered. **40:** 203–208. Jl. 1949.

Saura, Fulgencio. Observaciones en maices tetraploides. Revista Argent. Agron. **16**: 156–167. *f. 1–3 + tables 1–3.* S 1949.

Weber, W. W. Seed production in horseradishes. Jour. Hered. **40**: 223–227. *f. 9–12.* Au 1949.

PLANT PHYSIOLOGY

Addicott, F. T. et al. A method for the study of foliar abscission in vitro. Plant Physiol. **24**: 537–539. *f. 1–8.* Jl 1949.

Beal, Jack. Determination of quercetin-like substances in several midwestern plants. Trans. Kan. Acad. **52**: 209–218. 1949.

De Ropp, R. S. The action of antibacterial substances on the growth of *Phytomonas tumefaciens* and of crown gall tumor tissue. Phytopathology **39**: 822–828. *tables 1–4.* O 1949.

Ergyle, D. R. & Eaton, F. M. Organic acids of the cotton plant. Plant Physiol. **24**: 373–389. Jl 1949.

Haas, A. R. C. Orange fruiting in relation to the blossom opening period. Plant Physiol. **24**: 481–493. f. 1–5. Jl 1949.

Haas, A. R. C. Potassium in citrus trees. Plant Physiol. **24**: 395–415. *f. 1-4.* Jl 1949.

Hagen, R. M. Autonomic diurnal cycles in the water relations nonexuding detopped root systems. Plant Physiol. **24**: 441–454. *f. 1–11.* Jl. 1949.

Hammar, H. E. & Hunter, James H. Influence of fertilizer treatment on the chemical composition of Moore pecan leaves during nut development. Plant Physiol. **24**: 16–31. *f. 1–11.* Ja 1949.

Kelly, Sally. The effect of temperature on the susceptibility of plants to 2, 4–D. Plant Physiol. **24**: 534–536. *f. 1, 2.* Jl. 1949

Lakon, George. The topographical tetrazolium method for determining the germinating capacity of seeds. Plant Physiol. **24**: 389–394. *f. 1–4.* Jl 1949.

Leopold, A. C. Flower initiation in total darkness. Plant Physiol. **24**: 530–533. *f. 1, 2.* Jl. 1949.

Luecke, R. W., Hammer, C. L. & Sell, N. M. Effect of 2, 4–Dichlorophenoxyacetic acid on the content of thiamine, riboflavin, nicotinic acid, pentothenic acid and carotene in stems and leaves of red kidney bean plants. Plant Physiol. **24**: 546–548. Jl 1949.

MacDowall, F. D. H. The effects of some inhibitors of photosynthesis upon the photochemical reduction of a dye by isolated chloroplasts. Plant Physiol. **24**: 462–480. *f. 1–4.* Jl 1949.

MacVicar, Robert. The nitrogen composition of cereal grasses. I. Principal nitrogen fractions. Plant Physiol. **24**: 367–372. Jl. 1949.

Mitchell, John W., Wirwille J. W. & Weil, Leopold. Plant growth-regulating properties of some nicotinium compounds. Science **110**: 252–254. *f. 1 table 1.* 9 S 1949.

Muir, R. M., Hanch, C. H. & Gallup, A. H. Growth regulation by organic compounds. Plant Physiol. **24**: 359–361. *f. 1–3.* Jl. 1949.

Noggle, C. R. & Watson, S. A. The relationship of riboflavin and ascorbic acid to carbohydrate and nitrogen fractions in immature oat plants as influenced by mineral deficiencies. Plant Physiol. **24**: 265–277. Ap 1949.

Parker, M. W. & Borthwick, H. A. Growth and composition of Biloxi soybean grown in a controlled environment with radiation from different carbon-arc sources. Plant Physiol. **24**: 345–358. *f. 1, 2.* Jl 1949.

Porter, R. H. Recent developments in seed technology (concluded). Bot. Rev. **15**: 283–344. My 1949.

Rossman, E. C. & Stainforth, D. W. Effects of 2,4-D on inbred lines and a single cross of maize. Plant Physiol. **24**: 60–74. *f. 1–5*. Ja 1949.

Sideris, C. P. & Young, H. Y. Growth and chemical composition of *Ananas comosus* (L.) Merr., in solution cultures with different iron manganese rations. Plant Physiol. **24**: 416–440 *f. 1–8*. Jl 1949.

Smith, P. F., Reuther, W., & Specht, A. W. The influence of rootstock on the mineral composition of Valencia orange leaves. Plant Physiol. **24**: 455–461. Ja 1949.

Snyder, W. E. Some responses of plants to 2,3,4-triiodobenzoic acid. Plant Physiol. **24**: 195–206. *f. 1*. Ap 1949.

Stiles, I. E. Relation of water to the germination of bean seeds. Plant Physiol. **24**: 540–543. *f. 1–4* Jl 1949.

Taylor, C. A. Some factors affecting germination of celery seeds. Plant Physiol. **24**: 93–102. *f. 1–6*. Ja 1949.

Treitel, Otto. Elasticity, plasticity, water content, and hardness of plant tissues of different ages. Trans. Kan. Acad. **52**: 219–231. *1 f.* 1949.

Tryon, E. H. Color comparison of leaves of open and shade grown holly. Castanea **14**: 117–126. S 1949.

Tsao, Tsung-Hsun. A study of chemotropism of pollen tubes in vitro. Plant Physiol. **24**: 494–504. *f. 1–3* Jl 1949.

Vickery, H. B. *et al.* The problem of selecting uniform samples of leaves. Plant Physiol. **24**: 355–344. Jl 1949.

Went, F. W. & Hull, H. M. The effect of temperature upon translocation of carbohydrates in the tomato plant. Plant Physiol. **24**: 505–526. *f. 1–12*. Jl 1949.

Whittenberger, R. T. & Nutting, G. C. Effect of phytohormones on potato growth and the size of the starch granules. Plant Physiol. **24**: 278–284. Ap 1949.

Withner, C. L. Movement of P^{32} in maturing corn plants. Plant Physiol. **24**: 527–529. Jl 1949.

GENERAL BOTANY
(including biography)

Fernald, M. L. Charles Alfred Weatherby, botanist and helper of botanists. Rhodora **51**: 169–179. *port.* S [4 O] 1949.

Fernald, M. L. & Schubert, Bernice G. Bibliography of Charles Alfred Weatherby. Rhodora **51**: 179–191. S [4 O] 1949.

Pennell, Francis W. The last sickness of Rafinesque. Bartonia **25**: 67, 68. 12 O 1949.

Sax, Karl. John George Jack, 1861–1949. Jour. Arnold Arb. **30**: 345–347. *port.* 15 O 1949.